

Thread gage development. Paul A. Grobety.  
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FINAL REPORT  
THREAD GAGE DEVELOPMENT

ORDNANCE PROJECT OM49  
UNDER N D R C CONTRACT OMSr-487

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I. Scope of Project

Work on this project was started on April 20, 1942.

The project was initiated by the Ordnance Department of the U. S. Army for the purpose of breaking a bottleneck in the production of war material imposed by the limited capacity for the production of thread gages, especially ring gages. This bottleneck existed because of the fact that the design of such gages, the precision manufacturing requirements, and the methods available for their production were such that production was essentially a tool room job with time savings by mass production substantially impossible. Furthermore the demand for gages was made excessive by the fact that the life of gages within the wear limits allowed was generally a matter of a few thousand pieces. With threaded parts requiring thread gaging being manufactured by the hundreds of millions daily the problem of supplying the thread gage need became serious.

Work on the project was carried on under National Defense Research Committee Contract DEMsr-497 dated August 7, 1942 and made retroactive to the date of commencement of work. This contract specified the following items of performance:

- (1) Studies and experimental investigations in connection with the development of methods of thread gaging which will eliminate the use of thread, plug and ring gages or which will ameliorate wear resulting in rapid deterioration of the gage as a precision instrument.

- (2) Assembly of a comprehensive bibliography of screw thread gaging theory, practice and instruments from 1918 to the present time.
- (3) Development and construction of one or more models of such gaging equipment designed most nearly to meet the gaging requirements for the production of Army ordnance.
- (4) Delivery on or before the termination of the contract to the contracting officer or his authorized representative models of the gages developed and 100 copies of the bibliography in mimeograph form.
- (5) Furnishing of monthly reports on the progress of the investigation.
- (6) Furnishing of a final report at the termination of the contract.
- (7) Furnishing of specifications and drawings of models of such gaging equipment as may be developed under the contract.
- (8) Filing of patent application and execution of free licenses to the Government for use of patents, covering any inventions produced during the gage development.

This program of performance was established following a conference in the Gage Division of the Ordnance Department. This conference was attended by Mr. R. E. Flanders, President and Mr. E. L. Rose of the Jones & Lamson Machine Company and by Col. H. B. Hambleton and Lt. Col. W. J. Darmody of the Ordnance Department. In preparation for this conference Col. Hambleton had prepared a typed summary of the situation quoted in full in Appendix I.

Col. Hambleton's memorandum provided the background for a discussion, as a result of which it was decided there were a number of avenues along which a solution to the thread gaging problem might be sought. These were as follows:

1. By development of modified gage designs adapted to be salvaged by less work than that involved in the production of new gages and of satisfactory methods of salvage.
2. By the development of methods of manufacture for standard type gages adapted to mass production.
3. By the development of special treatments for the wearing surfaces of standard gages to reduce the rate of wear.
4. By the development of an entirely new type of gage adapted to mass production with the necessary precision.
5. By the development of an entirely new type of gage in which wearing elements were readily produced and readily replaceable.
6. By the development of an entirely new type of gage in which the causes of wear were substantially reduced or eliminated.
7. By some combination of two or more of the above.

It was determined that all of the above lines of attack should be investigated and that developments along several lines should be undertaken if found advisable in the interests of rapid progress.

The arts of screw manufacture and gaging are old. Many persons have participated in their development. The information regarding the arts is widely scattered. It was recognized that any effort toward any improvements in the art should be based on a thorough familiarity with what had been done in the past. It was pointed out that the only bibliography on the subject was one published in 1918 and prepared for the same purpose during the First World War. It was also found out that in making a proper survey it would be necessary to collect all the material required for an up-to-date bibliography and that such a

bibliography would be of great value to the War Department and to American industry. The preparation and publication of the Screw Thread Bibliography was therefore included as a part of the project.

Since the project was basically concerned with development of methods for the detection of errors in the production of threads and the problem was to be solved either by modification of the method of manufacture of gages or by modification of gage design the scope of bibliography was established as follows:

1. Theory of threads including geometry classification of errors and thread standards.
2. Methods and machinery and tools for the production of threads.
3. Methods and apparatus for the gaging of threads.

Before the project was completed the Ordnance Department undertook to provide temporary relief to the gage supply stringency by the letting of gage manufacture to small tool shops. It was found that few such shops knew the techniques of thread gage production. Furthermore no adequate description of gage production techniques had been published. There was, therefore, a need for a simple description of such techniques adapted to the use of personnel found in small shops. At the request of the Ordnance Department the gage contract was extended to include the preparation of a simple thread gage production manual.

## II. Performance Under the Contract

Reviewing contract items 1 to 8 in the order listed performance under the contract has been as follows:

1. In connection with the studies and experimental investigation.
  - a. The prior art was reviewed and material for a Screw Thread Bibliography was collected. The patent art was reviewed to see what it might suggest in the way of promising lines of development but since the art is very extensive no attempt was made to digest it for record.
  - b. Several "bread board" experimental models of gages were constructed the last of which was judged by Ordnance Gage Division Officers as worth reducing to production design.
  - c. Literature on methods of coating metals with hard materials was reviewed and unsuccessful exploratory tests on the application of tungsten carbide to the surface of steel were tried. This experience came at the end of the contract and in view of the very successful experience with the long wear life of the new gage it was deemed not worth while to extend the contract for the purpose of further development along these lines.
  - d. Material for a Manual of Instruction for thread gage manufacture was extracted from the bibliographical references and from discussions with experienced tool makers for publication under the extended contract.
2. The collection and assembly of bibliographical material was completed and 100 copies of the Bibliography printed in November, 1942.
3. Development of a production model of thread gage was completed and models shipped February, 1943. This model was sent into the field for service testing by manufacturers of Ordnance Components. Performance was extremely satisfactory on three counts:
  - a. In the hands of a competent operator the rate of gaging was five to ten times that of a standard ring gage.
  - b. The gage revealed errors not caught with the ring gage.

- c. After gaging 60,000 pieces the wear of the gage parts was not noticeable. At the same time the gage was adjustable for wear over a wide range so the potential life was many times 60,000 pieces. Gages now in service have handled as many as 300,000 pieces with the original contacting (shoe) elements.

As a result of this experience, at the request of the Ordnance Gage Section and with the approval of N.D.R.C., ten pilot models of the gage were produced and distributed, to plants producing ordnance components, for extensive service test. It is to be noted that the part for which this pilot model was produced was an unfinished, heat treated part producing extremely severe wear. The normal ring gage life on this part was in the neighborhood of 1000 pieces yet models of the new gage handled more than 60,000 pieces. Distribution of the pilot model gages is listed in Appendix III. Photostatic copies of receipts for these models were forwarded to Division 12, N.D.R.C., April 15, 1943.

4. One hundred and two copies of the Bibliography were delivered to the N.D.R.C. and distributed as follows:

11-28-42	2 copies	R. D. Booth, Vice Chairman Division C, Section C-3, NDRC
12-18-42	76 copies	P. C. Putnam, Ch. Technical Aide Section C, Division C-3, NDRC
12-18-42	24 copies	Dr. Irving Stewart, Executive Secretary NDRC

Other copies were distributed as shown in Appendix II.

5. Monthly reports were furnished with occasional exceptions but with sufficient regularity to reveal actual progress.
6. The present report constitutes the final report on the project.
7. Specifications and drawings are transmitted herewith.
8. Two patent applications, Serial No.'s 460961 and 488722 and patent disclosures were prepared and delivered to the Patent Department, N.D.R.C. on November 13, 1943. A Patent license in accordance with the terms of the contract was executed on November 13, 1943 and forwarded to the Patent Department, N.D.R.C. on January 27, 1944.



9. In accordance with the extended contract, 500 copies of the Manual of Thread Gage Manufacturing methods were printed and delivered, in accordance with instructions from Division C, Section C-3, NDRC, to:

460 copies	Chief of Ordnance Inspection Gage Sub-Office Philadelphia, Pa.	6-8-43
40 copies	Hartley Rowe, Chief Division 12, NDRC Room 1019, 41 Federal Street Boston, Massachusetts	5-28-43

The work on the thread gage bibliography and on the Manual of Thread Gage Manufacturing was done by employees of the Jones & Lamson Machine Company under the Prime Contract.

The work on the thread gage development and production of the pilot models was performed by employees of the Bryant Chucking Grinder Company under sub-contract to the Jones & Lamson Machine Company.

### III. Review of Gage Development

The development of the New Gage was rather straight forward. Preliminary consideration of the problem and of the various alternative solutions outlined at the beginning of the project lead quite directly to the conclusion that the only satisfactory solution was the production of a new type of gage and that the general form of the gage was rather clearly indicated by requirements of wear reduction and simplification of the process of manufacture of the gaging elements.

In order to avoid delays development of the gage design was started immediately and carried along simultaneously with bibliographical research. In the end the results of the bibliographical and patent search indicated that the design chosen was about the most satisfactory "all around" design that could be conceived.

Consideration of the various alternative lines of development initially outlined lead to the following general conclusions:

1. About the only practicable methods of producing simple renewable or salvageable gages appeared to be the provision of replaceable wearing elements or by chromium plating and refinishing worn standard gages.

In the conceivable forms of ring gages with replaceable elements the tendency to wear seemed to be increased. The replaceable elements required very precise assembly. Without treatment for increased wear resistance the designs appeared to offer little advantage over the standard gage.

To reclaim standard gages by chromium plating required refinishing, subsequent to plating, to the same precision and by the same methods as the original manufacture. Since the major part of the production time on gages is on the sizing and finishing operations there was little advantage to be gained by this procedure. The one

important advantage derived from the high wear resistance of hard chromium plate as compared with steel. Data on the improvement of life were found to be so conflicting that the probable gain could not be evaluated, but appeared to lie between factors of 1.5 and 100 depending on the service.

2. The manufacture of plug thread gages has been greatly facilitated, in recent years by the adoption of the thread grinder. However, the thread grinder has not yet been adopted for general use in the grinding of internal threads. Only of late has the necessary equipment for the grinding of internal threads reached the stage permitting the grinding of any but relatively large diameters. Even at that the limitations on size are still rather stringent and it will be some time before the grinding equipment becomes generally available. No other production method other than finishing on the thread grinder appears to offer much promise for improved production of ring gages. And this development is progressing as rapidly as can be expected.
3. Development of wear resistant surface coatings appeared to offer promise for usefulness in treating all gages and was therefore retained in the program.
4. The new type of gage indicated by the preliminary study turned out to be a gage reasonably well adapted to mass production since it could be produced on standard machinery by run of the shop machinists. It incorporated replaceable gaging elements which required only accurate forming of the thread section and accurate pitch but which did not have to be too accurately sized. They were therefore well adapted to production on the thread grinder or by tool room methods with ordinary operators or machinists. Finally it eliminated the main cause of wear so the gage elements could be expected to show a good life.

A study of ring thread gage wear shows that the gages always wear bell mouthed. If a thread is to be gaged through out its length, as is necessary to insure assembly, the gage must be turned on the thread a number of turns equal to the number of threads. As a result the successive threads of the gage are subjected to wearing action in proportion to their distance from the back end of the gage, since each succeeding thread is subject to wear over fewer turns. This results in the tapered wear.

Obviously the way to eliminate bell mouthed wear is to produce a gage into which the part can be introduced without threading on. If this procedure is followed then the part can be gaged with only a slight amount of turning to insure seating and to gage the full circumference. This generally requires only a fractional turn. The total wear on the gage elements is thus greatly reduced and the life prolonged.

Following this reasoning, consideration was first given a design incorporating two threaded rollers mounted on fixed parallel axis and one roller on a moveable axis parallel to the other two. The moveable roller was mounted at the end of a pivoted arm with pivot axis parallel to the roller axis, the three rollers being approximately equally spaced angularly about the axis of the piece to be gaged. A dial indicator bore on the pivoted arm to indicate its position and thereby the deviation in size of the work. To perform a gaging operation the moveable roller was lifted away from the fixed rollers and the work introduced between them. Upon releasing the arm the moveable roller bore down upon the work pressing it against the fixed roller, the dial indicator bearing against the arm. The dial indicator zero setting was established by inserting a master reference workpiece.

The arrangement is shown schematically in Figure 1. The appearance of a simple model is illustrated in the photograph Figure 2. This model was prepared primarily to study the engagement between the threaded rollers and the work. It was found that the design had several undesirable features, as follows:

1. With threaded rollers the phasing of the rollers to insure simultaneous seating required excessively complex mechanism.

2. If simple grooved rollers were used they had to be "skewed" to match the lead angle of the thread. To insure proper engagement the rollers must be short and it was not possible to gage the entire length of thread in one setting.
3. In gaging dirty or oily parts dirt accumulated on the surface of the rolls and there was no wiping action to remove it. Gaging was therefore not uniformly accurate.

The purpose in attempting to use roller gaging elements was to keep the wear down by eliminating sliding contact between work and gage. Following the above observation it was decided that it would be necessary to accept sliding contact both to provide wiping for dirt removal and to avoid the mechanical problems introduced by the rollers. The gage was therefore modified to incorporate three threaded shoes in place of the three rollers, the method of gaging by dial indicator bearing on a moveable gage element being retained. The shoes were produced with relatively narrow bearing faces having sharp corners to scrape away dirt. The shoes were of such length as to engage the contact through the full length of the thread being gaged. Models of shoe type gages were prepared for both internal and external threads. The general arrangement of these gages is shown schemmatically in Figures 3 and 4. A very important detail of these gages is the flat spring pivot. This provides the best method available for a frictionless and accurately fixed pivot for limited motion.

At the suggestion of the Ordnance Department, experimental models were prepared for the 2"-12NS-1 thread on a component of the M-21 Booster. Models were constructed for both male and female threads of this size and pitch. These gages are illustrated by photographs, Figures 5 and 6.

During the early stages of the development it was recognized that the design hit upon not only offered a solution to the problems of thread gage production and thread gage life but it also offered an opportunity to greatly reduce the labor of thread gaging. Efforts were therefore made in the interests of gaging speed to make the operation of the gage as nearly automatic as possible. For this purpose the moveable element was held open by a spring and closed by a solenoid. A micro switch controlled the solenoid and was actuated by a small pin between the fixed shoes. When a workpiece was pressed against the fixed shoes it engaged the pin, closed the micro switch and thus operated the solenoid to close the gage. A moderate hand pressure against the workpiece to cock it slightly was sufficient to release the gage. This arrangement is illustrated in the arrangement drawing, Figure 7.

The model gages described above were exhibited to the Ordnance Department Gage Section now located at Frankford Arsenal. They were well received and the opinion was expressed that perfection of the development opened up an entirely new approach to problem of thread production and gaging. The models were left with the Gage Department personnel with a request that criticism and suggestions for improvement be forwarded to us after a study of the gage operation. The comments received in response to the request are presented in a letter from Col. Darmody, Appendix IV.

Following the presentation of the above models it was suggested by Col. Darmody that a second model be constructed for the gaging of the windshield mounting thread on the hardened A.P. cap of the 40 mm. solid shot. This part which is hardened after machining and not ground is



very hard on thread gages. At the time the suggestion was made the life of a gage was in the neighborhood of 1000 pieces.

This part was being made in great quantity. Consideration of this fact brought a realization that here as in all cases where gage wear was an important consideration general reliability of operation and freedom from service were equally important. In other words, it was not only essential to minimize replacement for wear but also to minimize the removal of gages from service for any causes. For this reason it was decided to compromise on speed of operation for the sake of reliability. The automatic closing and opening feature was therefore eliminated. The final gage model was operated by hand.

The production model of gage for the A.P. Cap was completed about February, 1943. A full set of assembly and detail drawings for this gage is transmitted herewith. The general appearance of the gage is shown in the photograph, Figure 8. This gage was taken to several plants producing components where, in each case it was used in the production line.

This gage was from five to ten times as fast as the conventional ring gage. Instead of screwing the component into the gage operation consisted of opening the gage by squeezing the lever, inserting the part, releasing the lever and giving a half turn to seat and check roundness. These successive steps run one into the other in such a manner as to constitute what is substantially a single continuous operation.

The gage described herein was designed primarily as a "go" gage for male threads to take the place of the conventional ring gage. A "go" gage serves the purpose of checking parts to insure proper assembly. Mating parts which pass properly designed and manufactured "go" gages will assemble together with fits which are no tighter than intended by the designer of the gages.

When gages wear rapidly excessive allowances must be made for wear. As a consequence parts checked during the early life of the gage fit together too loosely and parts gaged during the later life fit too tightly. The present gage can be kept in continuous adjustment by resetting the dial indicator against a master plug inserted in the gage. Since the wear is slight the thread form changes slowly and the gage can be reset many times without sacrifice of accuracy.

Ring gages are generally produced by first roughing out a thread by machining, then bringing to size and proper finish by lapping. During the lapping process compound tends to accumulate in the bottoms of the thread grooves. As a consequence the tops of the threads are worn down so the gage thread tends to be slightly rounded or truncated. Lapping is not a necessary operation in forming threads for the new gage. Consequently the thread form tends to be truer. As a consequence it has been found in service that the new gage rejected many parts produced by worn dies with rounded thread tops, which had been passed by new ring gages.



Not only does the new gage serve as a "go" gage, it also operates as a "not go" gage in checking pitch diameter. The gage will reject undersized parts where the thread form is reasonably true.

Pitch errors are rejected by an oversize indication provided the pitch diameter is not sufficiently undersize to produce an assembleable screw. Excessive and short pitch both show the same indication.

The "go" gage will not check thread form. However, with a "not go" gage of similar construction having threads relieved so as to bear only on the pitch line, all of the checks of a pair of "go" and "not go" ring gages can be duplicated.

The only practicable method for making a detailed check of thread form is by means of an optical, projection type comparator. This however is not a practical inspection device where millions of threads are to be checked. Nor is its continuous use necessary. Routine gaging with a "go" type production gage accompanied by periodic checks of thread form on the comparator for control of tooling are capable of maintaining all but the most extreme standards of high quality.

#### IV. Treatment of Gage Elements to Improve Wear Resistance

Investigation revealed a number of methods, potentially useful for the treatment of gage parts to insure wear resistance. The only one offering the possibility of extreme improvement appeared to be the application by some means of a layer of tungsten or other hard carbide. If means could be found for making such application in uniform, thin layer to the surface of a finished gage the results should be remarkable. Unfortunately the problem appeared to be one requiring development on a much more extensive basis than was justifiable under this contract. The findings of this investigation are reviewed briefly below:

##### a. Use of Soft Gage Elements

The wear of gage elements is largely due to the lapping action of dirt on the work surface. When a hard gage is used on soft parts gage wear is generally more rapid than when gaging hardened parts, except where the hard parts are not ground. Often brass and aluminum tend to wear gages faster than hardened steel. This is due to the fact that dirt particles tend to become imbedded in the soft material and are dragged across the surface of the gage during gaging. When gage and work are of substantially the same hardness this does not occur. The dirt then rolls in the space between gage and work surfaces.

For the above reasons soft steel gages generally wear better than do hardened steel gages. However they have the undesirable feature of being easily dented and deformed in handling. If they are not handled carefully and inspected frequently for nicks and dents they are not reliable.

##### b. Pentrate and Other Treatments

The "Pentrate" treatment is one of the many processes for the formation on metal surfaces of oxide or sulfide films. The pentrate treatment produces a sulfide film.

Sulfide films have the property of reducing the coefficient of friction and in the case of simple frictional wear may reduce the rate of wear of the treated surface. However, as has been pointed out above, gage wear is due largely to the lapping action of dirt and sulfide films will not stop this.

Ordnance Department tests have shown two incidental advantages deriving from the use of Pentrate treatment on gages. In the first place the pentrate greatly retards the surface corrosion resulting from handling. Pentrate treated gages remain clean and uncorroded for long periods of use. In the second place the pentrated surface is thin and its color is black. Small nicks in the gage surface show up to visual inspection and it is not necessary to make frequent inspections with a magnifying glass to check for them. Furthermore, the change of color of the surface from black to metallic white as wear progresses provides a visual warning of the state of wear of the gage. The time for dimensional checking is clearly indicated by the change of color.

#### c. Chromium Plating

The most successful method for prolonging the life of gages, yet developed, is the use of chromium plating. Hard chromium plate on the surface of a gage increases the life of the gage, from a slight amount up to as much as one hundred times. The reason for the wide variation is again the lapping action of the dirt on the work. The extreme increases in life are found in the gaging of clean hard parts. The less extreme in the gaging of soft parts. In very bad cases the improvement may be negligible. Chromium plate has a high hardness (about 900 Brinnell) and a low coefficient of friction. Its resistance to ordinary frictional wear is remarkable. But it is very little better than steel in resisting lapping abrasion.

#### d. Carbide Coatings

To get away from the abrasion wear problem it is necessary to coat the gage surface with a material having a hardness greater than that of the major part of the dirt on the work surface. Boron carbide is the hardest of all synthetic materials. It stands up well in sand blast nozzles. Gages made of boron carbide have showed almost indefinite life. However, the material is extremely

brittle so that gages made of it must be specially designed to eliminate sharp corners. The material would be quite unsuitable for use in thread gages, unless a process could be found for applying it to surfaces in thin films. At present no such process is apparent.

Tungsten carbide is not as hard as boron carbide but it is tougher and easier to handle. It was thought that films might be applied to thread gage surfaces and several methods were tried.

A mixture of cobalt and tungsten carbide powders in thin lacquer was painted on and sintered near the melting point of the steel. Two faults were found with the result. The deposit was irregular and not of uniform thickness. The sustained heating so close to the melting point of steel caused excessive grain growth.

An effort was made to spray tungsten carbide powder on to the surface through an atomic hydrogen arc. When the arc was held in contact with the work long enough to produce a good bond excessive grain growth occurred. Without sufficient heating the bonding was unsatisfactory. Difficulty was experienced in producing a sufficiently uniform deposit to offer prospect of finishing with a reasonable amount of labor.

The work on these investigations was carried far enough to indicate that while the ultimate accomplishment might be within the realm of possibility it would certainly take a development program far more extensive than that provided for in the Thread Gage Contract.

During the later stages of the study it was learned through references in the German literature that a possibility existed for producing films by deposition of metals from the carbonyl vapor. Most carbonyls are unstable at relatively low temperatures, breaking up to give CO and the metal constituent. By keeping the metal surface at a temperature above the cracking temperature of the carbonyl, the metal from the carbonyl can be deposited on the hot surface. A film thus deposited might be carburized in place. Here again there is a very difficult problem of producing a good bond, and an extensive research program for the development of the process was indicated.

In view of magnitude of the job it was decided that no effort should be made to carry through the carbide coating development. This decision was agreed to by the Chief of the Division at a conference in Boston. By this time the new gage had received extensive service tests and it had become apparent that the wear problem had become much less critical in view of the indicated long life of the new gaging elements. This observation was the final factor in establishing the decision.

V. Conclusion

A new type of thread gage adapted to production use with increased life, less labor and with entirely satisfactory gaging results has been developed. Production models have been tested in service and advantageous performance conclusively demonstrated. Gages now in use have gaged 300,000 parts and more, with the original gage parts and without excessive loss of discrimination.

A bibliography on threads and their manufacture and gaging has been prepared and delivered as has a monograph on thread ring and plug gage manufacture. Gage drawings and specifications are transmitted herewith. All terms of the contract have been met and the performance required under the contract is considered to have been completed.

## HIGH PRODUCTION THREAD GAUGE

### SPECIFICATION

#### 1. DESCRIPTION

This thread gauge was designed for speeding up thread inspection over conventional methods with ring gauges or thread micrometers.

The thread to be inspected is placed between two gauging elements, one of which is fastened to the base and the other is mounted on a pivot arm. The threaded work piece is pinched in between these two gauging elements and the position of the pivot arm is registered on a dial indicator. With this arrangement, it is possible to obtain comparative measurements between a master thread and the work to be inspected.

Drawing GGA-25 shows an assembly of this thread gauge. The stationary gauging element GG-22 is mounted on the base GG-29. The movable element is fastened to the same pivot arm GG-15 as the hand lever GG-16. The pivot arm in turn is attached to the base by means of two pairs of reeds GG-25 located at right angles to each other. This arrangement eliminates all play or back lash at the pivot points of the gauge lever.

The threaded portion of the single gauge element is located in line with the pivot point in order to keep errors due to the circular motion at a negligible minimum.

A dial indicator #13523 is mounted on the base in such a way that the stem follows the movements of the gauge lever.

Between the two gauging elements is located a work holder with four support pins GG-23. It is mounted on a leaf spring GG-24 which in turn rests loosely on the base. This flexible mounting always permits perfect mesh between the gauging elements and the thread on the work.

In operation, the gauge lever is moved to the left and the work piece is inserted between the two gauging elements and between the four support pins of the work holder until it rests on top of these pins. The handle



is then released and the work piece rotated approximately one full turn in order to obtain a reading on the thread diameter over the whole circumference. The pressure on the work between the gauging elements does not depend on the operator's touch but is uniformly controlled by a coil spring #15060.

## II. MANUFACTURING INSTRUCTIONS

The most important points in the manufacture of the thread gauge are the proper machining and mounting of the thread segments and the gauge lever.

The thread segments are machined out of one solid ring. Usually two sets can be made of one part as shown on print GC-22. The blank is first machined as shown in Figure 1 and then heat treated. After hardening, both sides are ground on a surface grinder and the thread is ground very accurately on an internal thread grinder. After this, the ring is cut into the various segments.

The reeds for the gauge lever pivot are made of spring steel. They have to be securely anchored to the base and the gauge lever. If screws are used, they should have a taper or concave radius under the head in order to prevent the reeds from slipping. Rivets have been found even better than screws.

After the gauge lever has been assembled into the base, both locating surfaces for the thread segments are ground in one plane together. In order to insure proper alignment between the two segments, care must be taken to assemble them in the same mutual position as they had when they were still part of the blank. A final check of the alignment can be made by inserting a thread plug gauge of the correct size with a little Prussian Blue.

Bryant Chucking Grinder Company  
Paul A. Grobety  
January 25, 1945



## A P P E N D I X I

### Ordnance Department Memorandum

#### A PROJECT TO DEVELOP NEW MEANS FOR GAGING SCREW THREADS

by

Col. H. B. Hambleton, Ord. Dep't., U. S. Army

#### 1. Present Practice of the Ordnance Department

Ordnance thread inspection gages are designed in accordance with the practice outlined in the Screw Thread Standards for Federal Services, National Bureau of Standards Handbook H-25, and the practice of the American Gage Design Committee outlined in the publication Commercial Standard, C.S.8-41. The practice outlined in these publications is based on coordination between and recommendations of American Industry and Government Agencies during the past twenty years.

For the inspection of components with male threads, adjustable snap gages are used for inspection of major diameter and Threaded Go and Not Go Ring Gages inspect all other dimensional elements of the male thread. Threaded Check Plugs are used to set the Go and Not Go Thread Rings which are adjustable.

Components with female threads are inspected for minor diameter with plain plug gages, and threaded Go and Not Go plug gages inspect all other dimensional elements of the female thread.

#### 2. Scope and Objective of the Project

A research and development project to find a new means to gage screw threads should have as its objective the following:

"To secure interchangeability, that is, the assembly of mating parts, without selection or fitting of one part to another, and to insure that the product conforms to these specified dimensions within the limits of variation establishing the closest and loosest conditions of fit permissible in any given case."

The scope of such a project should consider only devices other than those referred to in appendix 3, section 6 pages 150 to 152, Screw Thread Standards for Federal Services. A study of this appendix will reveal that the search for new means to gage screw threads has been in progress for many years. It will also reveal that there are numerous devices suitable for use as Not Go thread gages, but that the only devices now available that meet the interchangeability requirements stated in the above objective are Go thread plug gages and Go thread ring gages. Accordingly, the specific objective of the project should be to develop a substitute for

Go thread plug gages and Go thread ring gages. To insure interchangeability, the substitute device must control the following dimensional elements of screw threads within the permissible maximum metal conditions of mating male and female threads:

- (a) pitch diameter
- (b) minor diameter
- (c) lead and angle error
- (d) taper and cut of round
- (e) imperfect or damaged threads
- (f) required length of perfect thread
- (g) periodic error of lead
- (h) concentricity of pitch, major and minor diameters

### 3. Alternate Scope of the Project

To develop means of increasing the wear life of existing types of thread gages. Chrome plating offers the possibility of greatly increasing the wear life of thread gages. The Lincoln Park Gage Company is now producing chrome plated thread gages and they have apparently overcome some of the difficulties and objections that have been encountered in efforts to plate thread gages during the past fifteen years.

Another alternative scope could be to develop new and faster methods of producing the existing types of thread gages.

### 4. Suggest Approach to the Project

- (a) A survey of gage manufacturers to determine new devices now in the research, experimental or development stages.
- (b) Coordination with the Interdepartmental Screw Thread Committee and the American Gage Design Committee.

### 5. Devices which offer Promise for Development

- (a) Pneumatic gaging as conceived by Harrington in U. S. Patent No. 1437053, November 28, 1922.
- (b) Photo Electric means as conceived by Lt. D. C. Eisendrath of the Gage Section, Chicago Ordnance District.

## A P P E N D I X   I I

### DISTRIBUTION OF THREAD GAGE BIBLIOGRAPHY

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A P P E N D I X   I I I

DISTRIBUTION OF PILOT MODEL GAGES

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A P P E N D I X IV

War Department  
Office of the Chief of Ordnance  
Inspection Case Sub-Office  
238 E. Wyoming Ave.  
Philadelphia, Pennsylvania

August 28, 1942

Mr. Edwin L. Rose  
Jones & Lamson Machine Company  
Research Department  
Upper Shop  
Springfield, Vermont

Dear Mr. Rose:

We are returning by express the two thread gage models which you left with us on August 20, 1942 for study and suggestions. Gage personnel of Frankford Arsenal and myself have carefully studied the models and we agree that the working principles incorporated in the devices should be immediately used in the development of a pilot model for production use on the application outlined to you during your visit.

You requested comments and criticism on these devices and we offer the following, not as criticisms but as suggestions for your consideration:

- (a) Rough surface finishes on component threads may set up chatter or vibration during the one-half turn rotation. To overcome this, we suggest a dash pot or other dampening device on the amplifying contact arm.
- (b) Colored lights to indicate acceptance or rejection should be the preferred means of indication.
- (c) Design to provide a diameter range. The device appears well suited for the incorporation of diameter range as the interchange of chaser elements will provide for variation in thread pitch.
- (d) The contacting force of the movable contact element will probably require experimentation. Components with threaded ends and offset elements may introduce moments that result in



Mr. Edwin L. Rose  
Jones & Lamson Machine Co.

-2-

August 28, 1942

misalignment of the axis of thread with reference to the axis of the gaging device. Fortunately it appears that the only limitation on the contacting force will be the element of wear on chasers resulting from the one-half turn rotation.

- (e) The Go gaging device should be very sensitive near the maximum metal limits of the component. The Not Go gaging device should be very sensitive near the minimum metal limits of the component. Ordnance gaging practice applies gage tolerances and wear allowances so that some components slightly within component drawing limits may be rejected, but so that all components outside of limits are rejected. The Ordnance gage designer is never permitted to take liberties with component tolerances in the design of inspection gages.

You have probably considered previously the above matters but we offer them for what they may be worth.

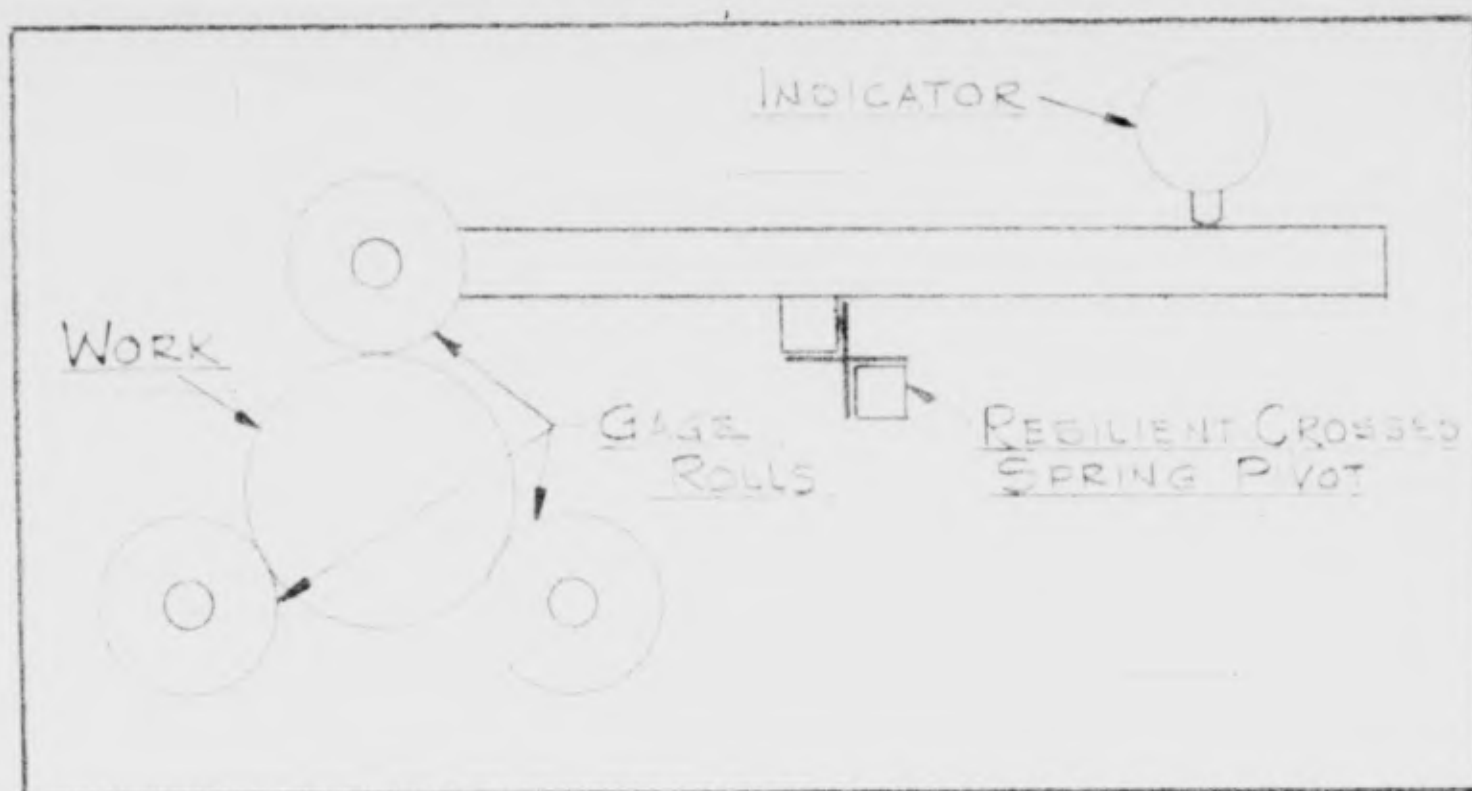
Inclosed is a print of Drawing 72-2-276 for the 37 m/m APC Shot which you will need for the development of the pilot production model. Also inclosed is a print of gage drawing B23155 which pertains to the thread gages now used on the 1" - 32WS-2 thread. The truncation, lead error, and angle tolerances for the chasers should be as outlined for gages on Drawing B23155. You will note that the Go thread ring on Drawing B23155 includes an element for checking length of thread. It will not be necessary to include inspection of thread length in the device you are developing under Project O.D. 49.

It is gratifying to observe the progress that has been achieved under Project O.D. 49. Early completion of the pilot model for production use will be a valuable contribution towards eliminating the bottleneck of thread ring gage production.

Sincerely yours,

WM. J. DAKIN  
Lt. Col., Ordnance Department

2 Incls.  
Drawing 72-2-276  
Drawing B23155



SCHEMATIC ARRANGEMENT  
ROLLER TYPE THREAD GAGE

Fig. 1



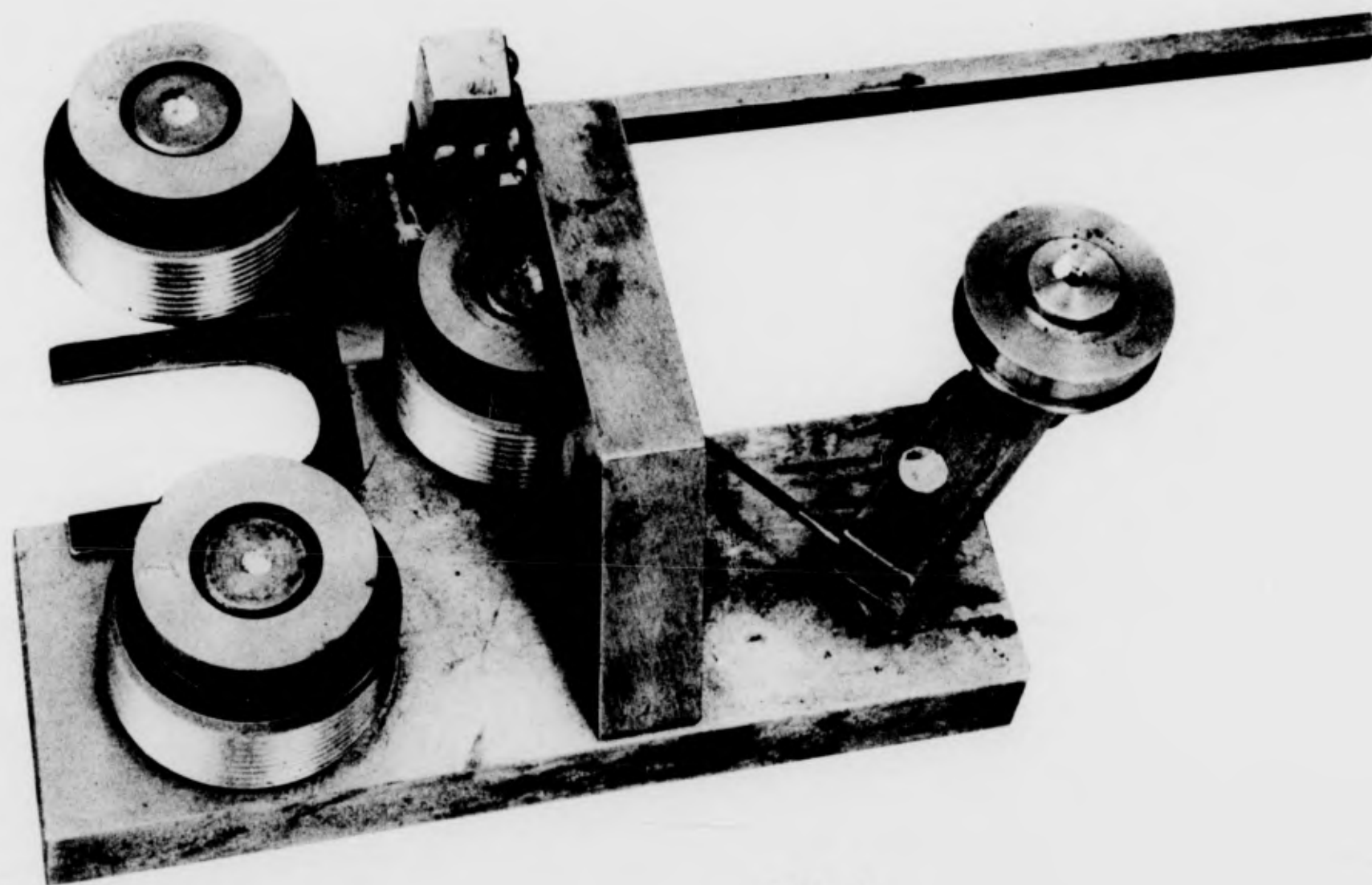
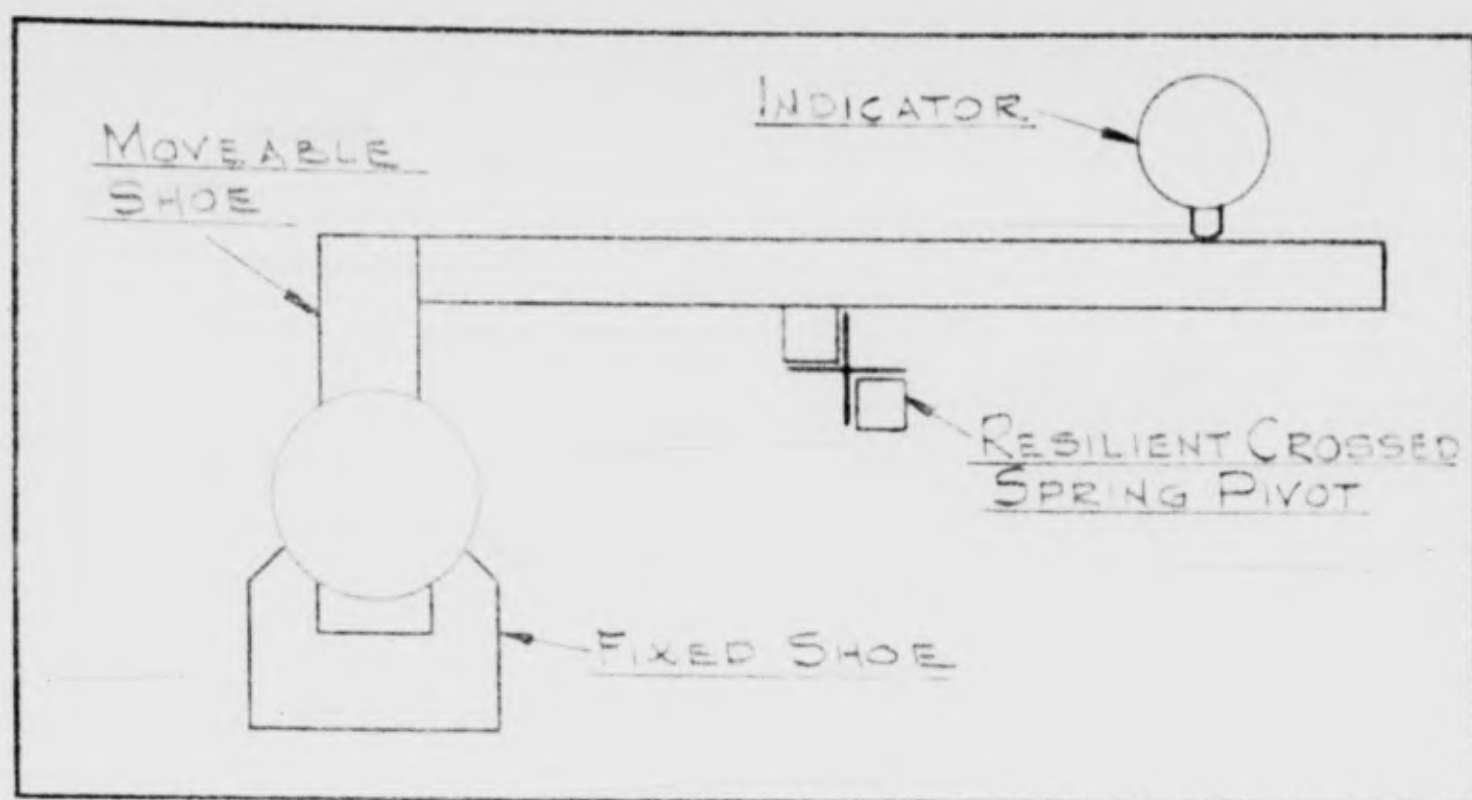
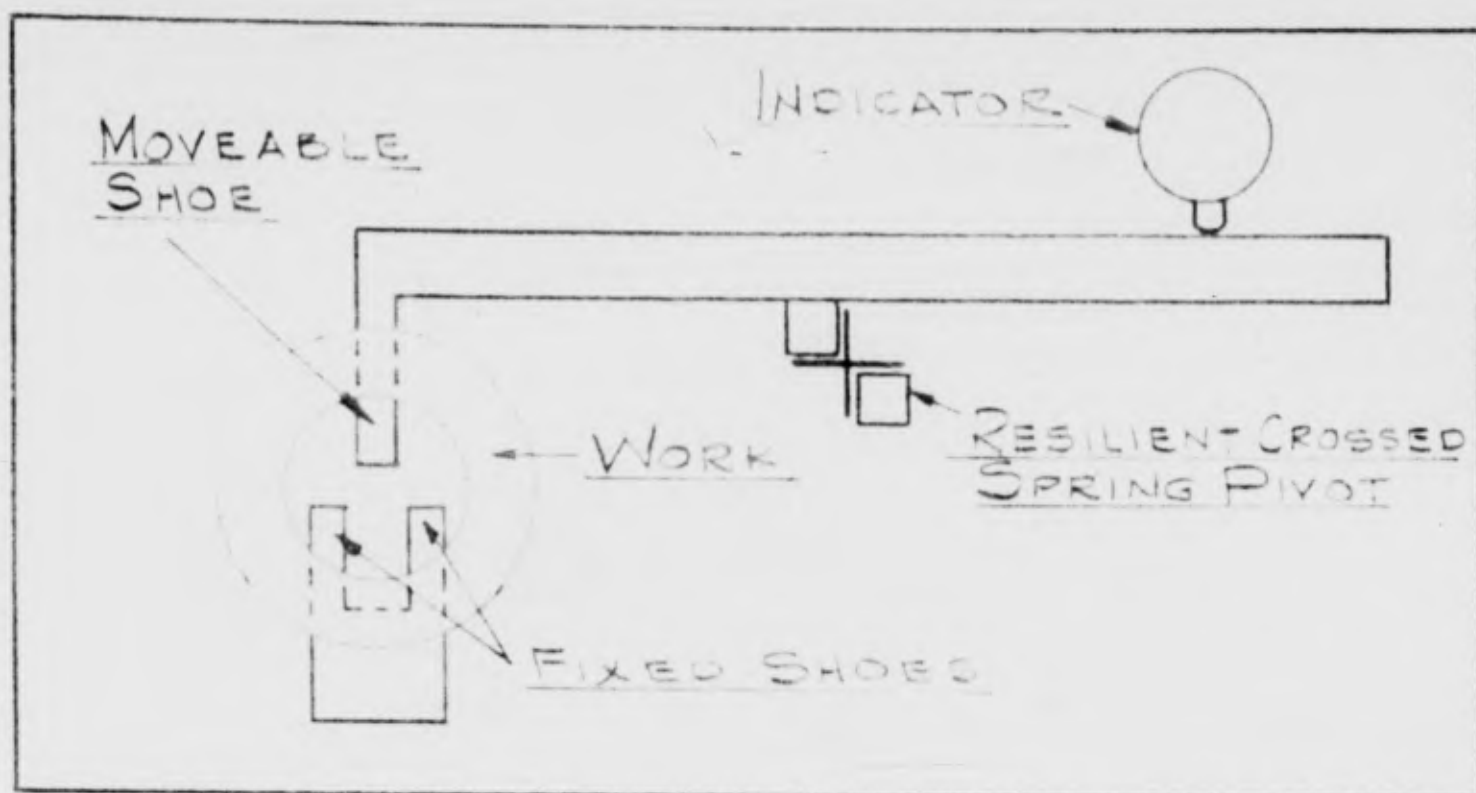


FIG. 2



SCHEMATIC ARRANGEMENT  
SHOE TYPE GAGE FOR EXTERNAL THREADS

Fig. 3



SCHEMATIC ARRANGEMENT  
SHOE TYPE GAGE FOR INTERNAL THREADS

Fig. 4

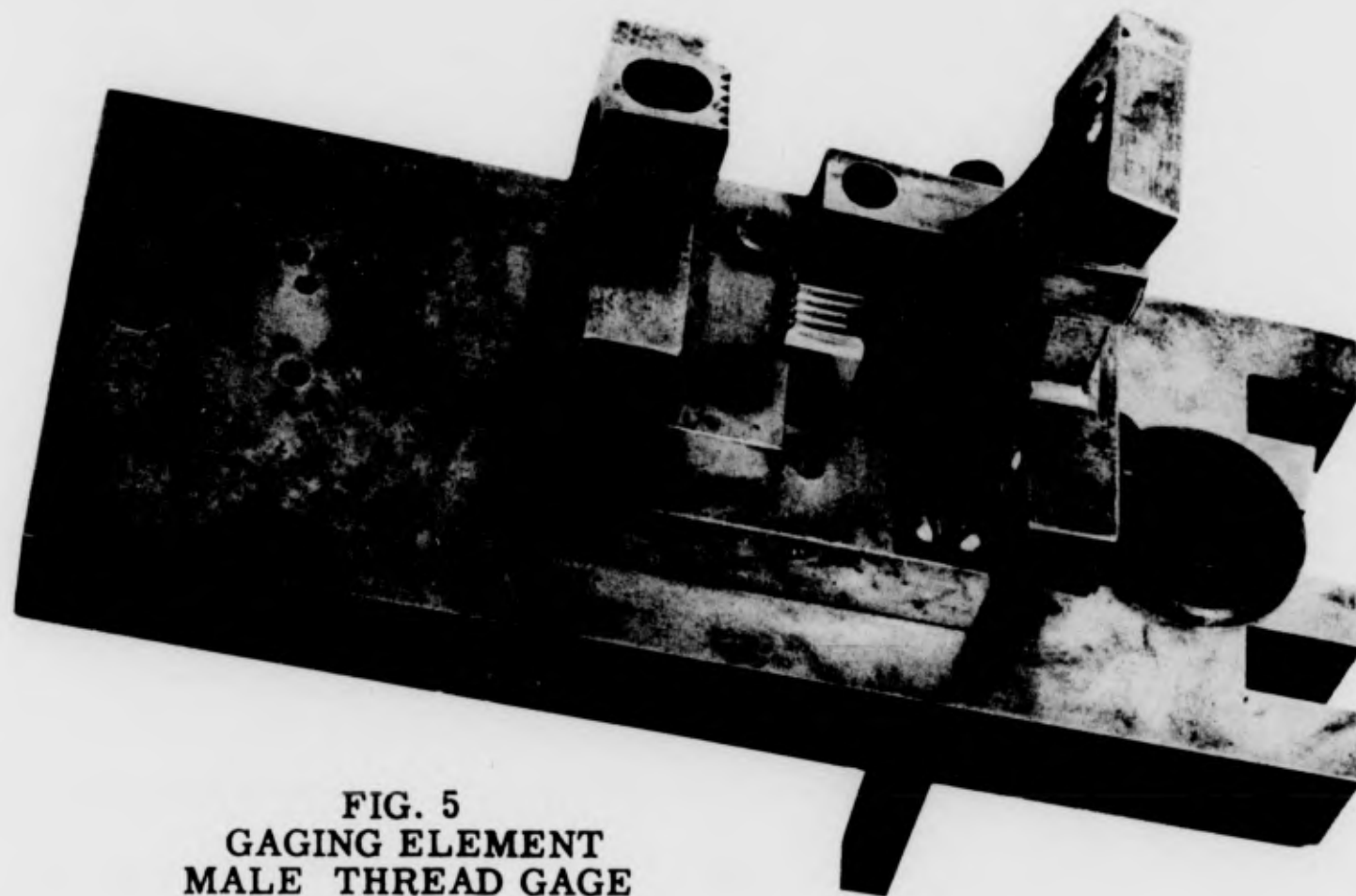


FIG. 5  
GAGING ELEMENT  
MALE THREAD GAGE

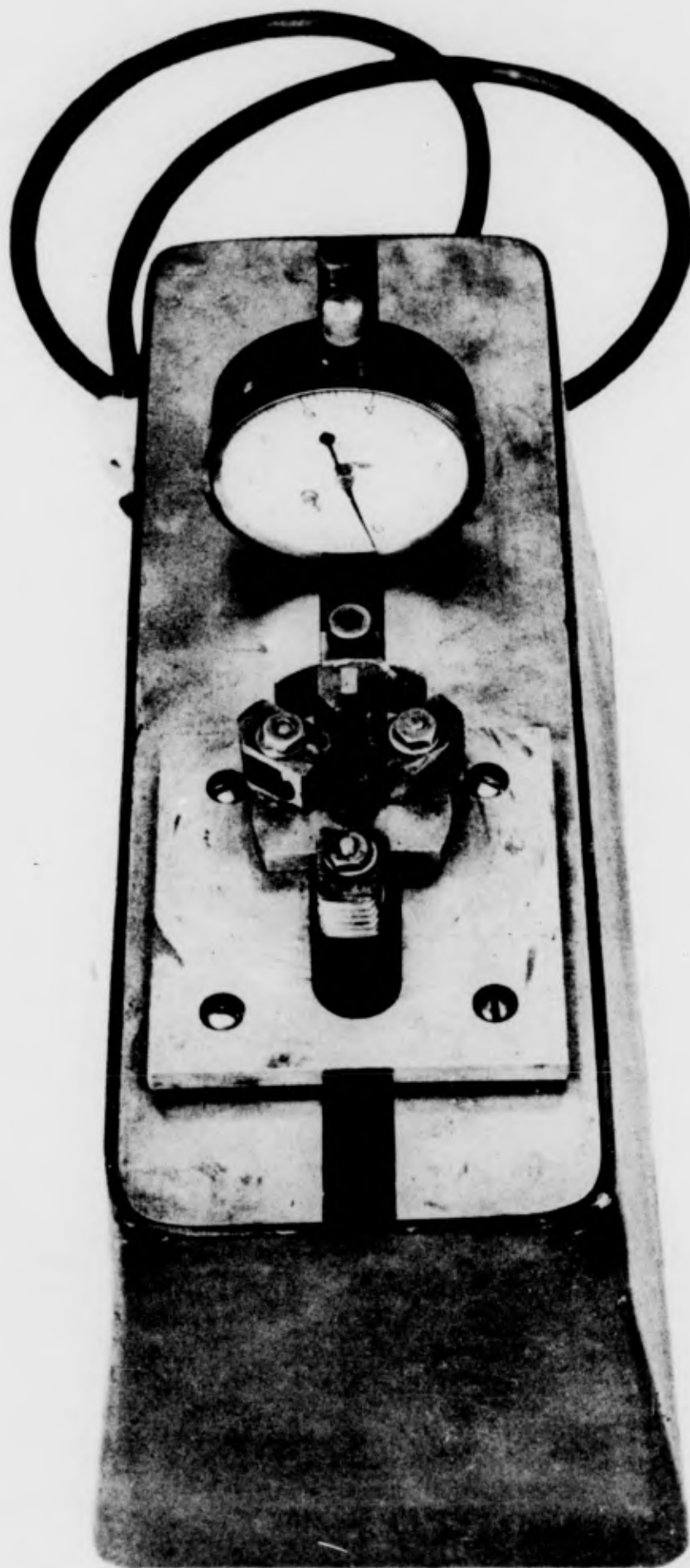
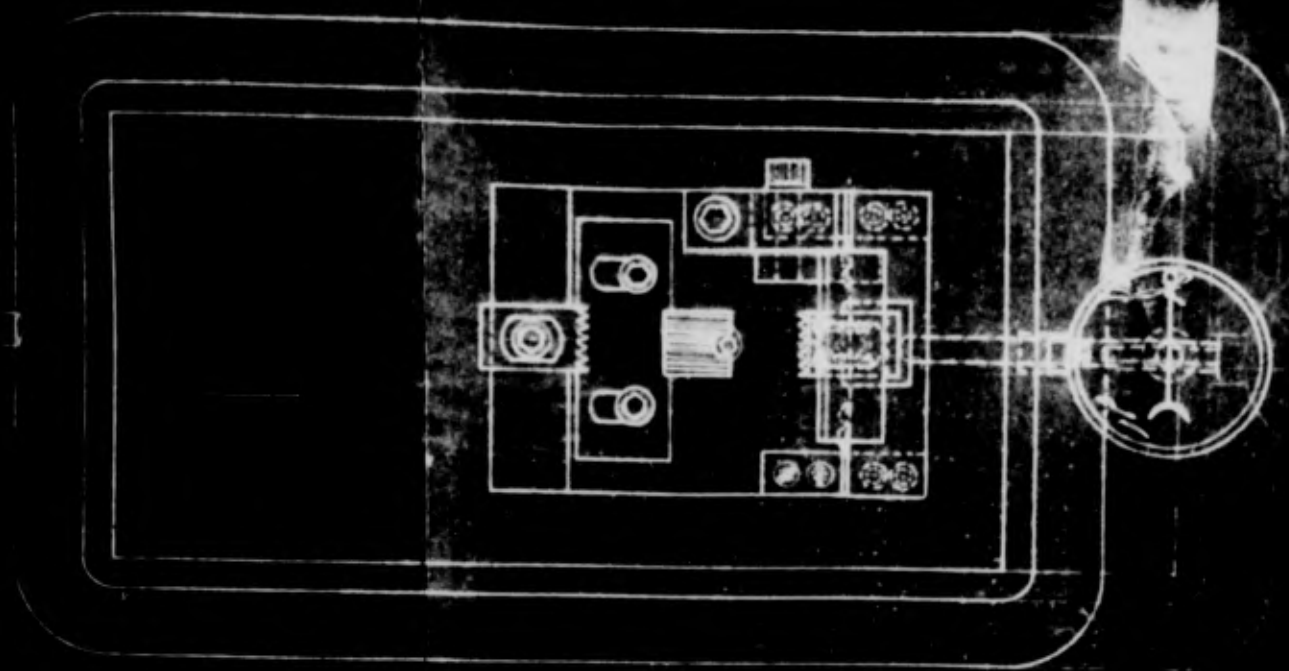
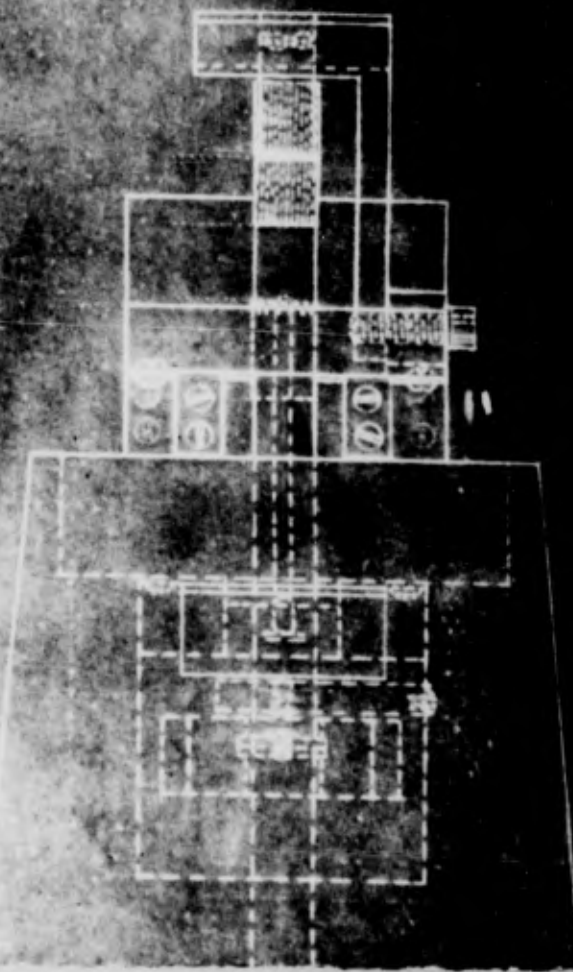
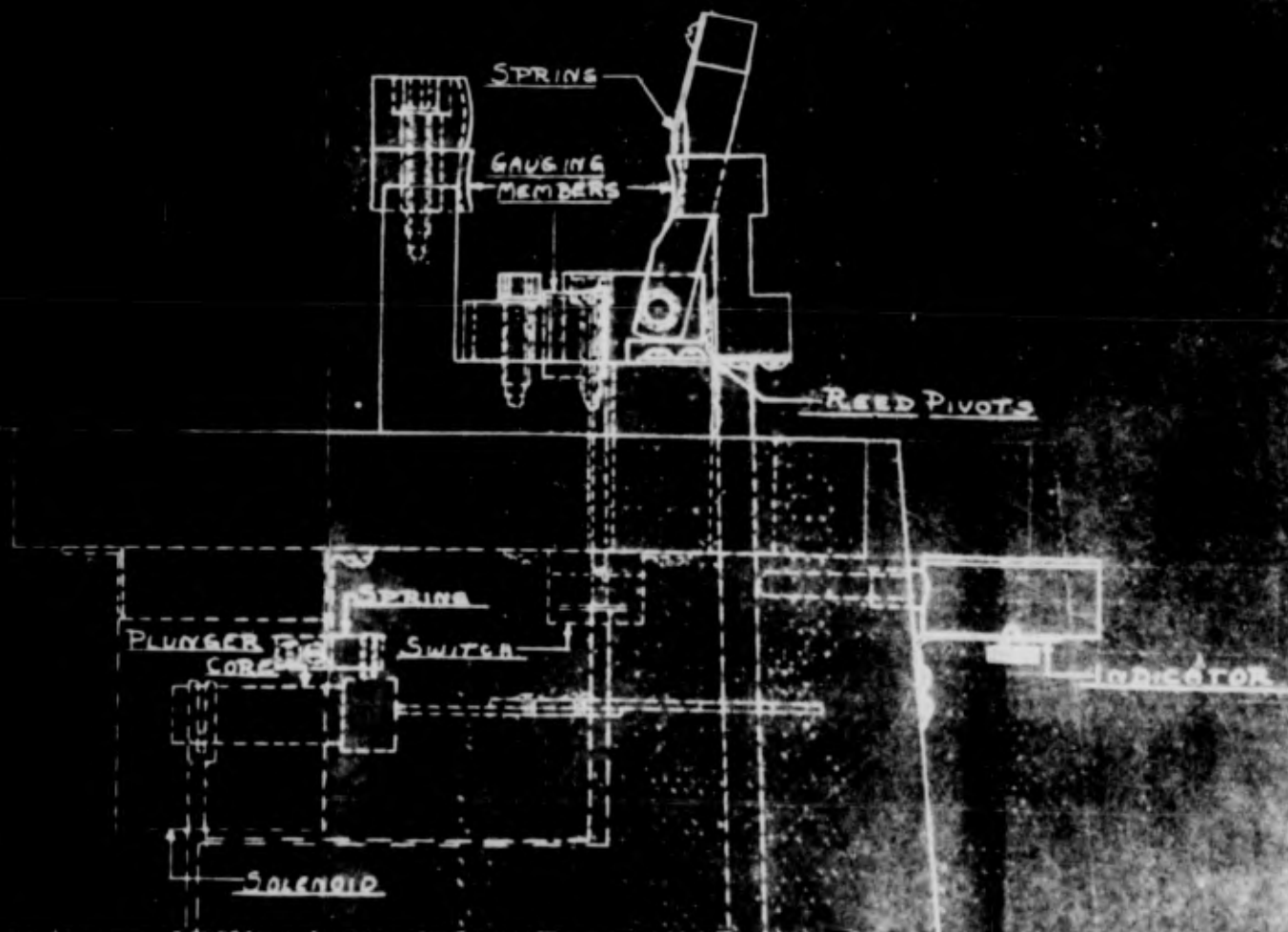


FIG. 6  
ASSEMBLED GAGE  
FOR FEMALE THREADS



Copy of design shown to Army  
Ordnance Aug 20, 1942



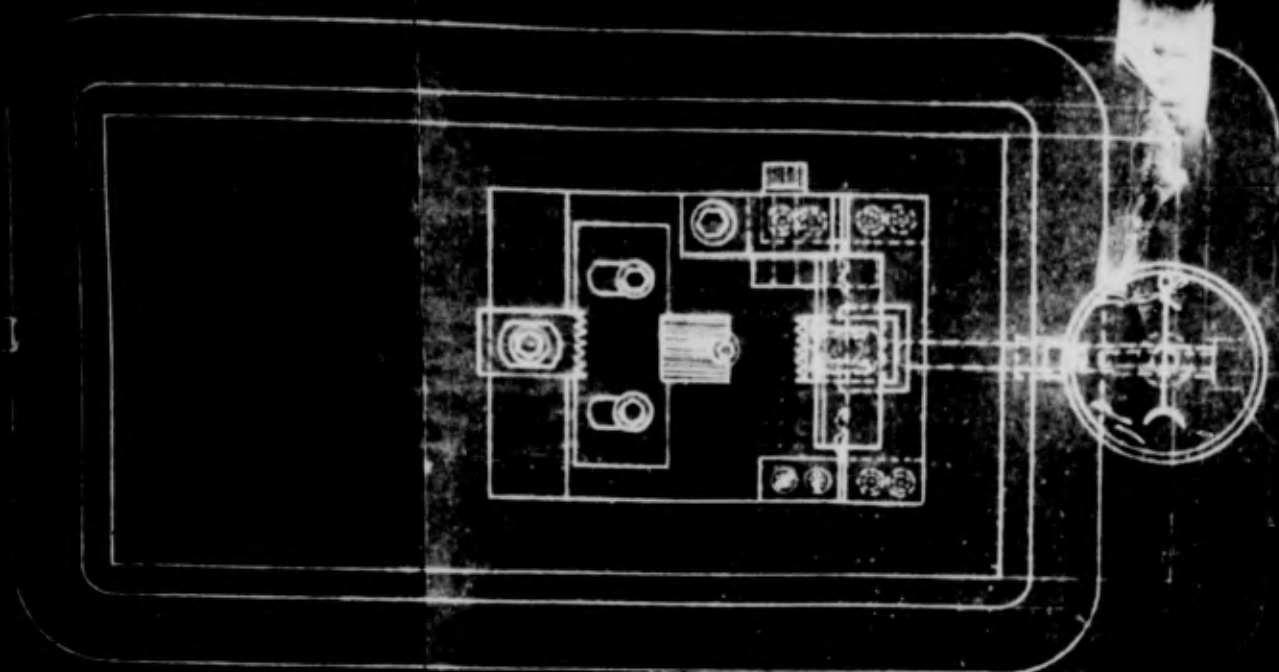


# CORRECTION

THIS DOCUMENT  
HAS BEEN REPHOTOGRAPHED  
TO ASSURE LEGIBILITY

10 A.C.

Fig. 1  
ALTERNATE THREAD GAUGE  
Scaled Full



Copy of design shown to Army  
Ordnance Aug 20, 1942

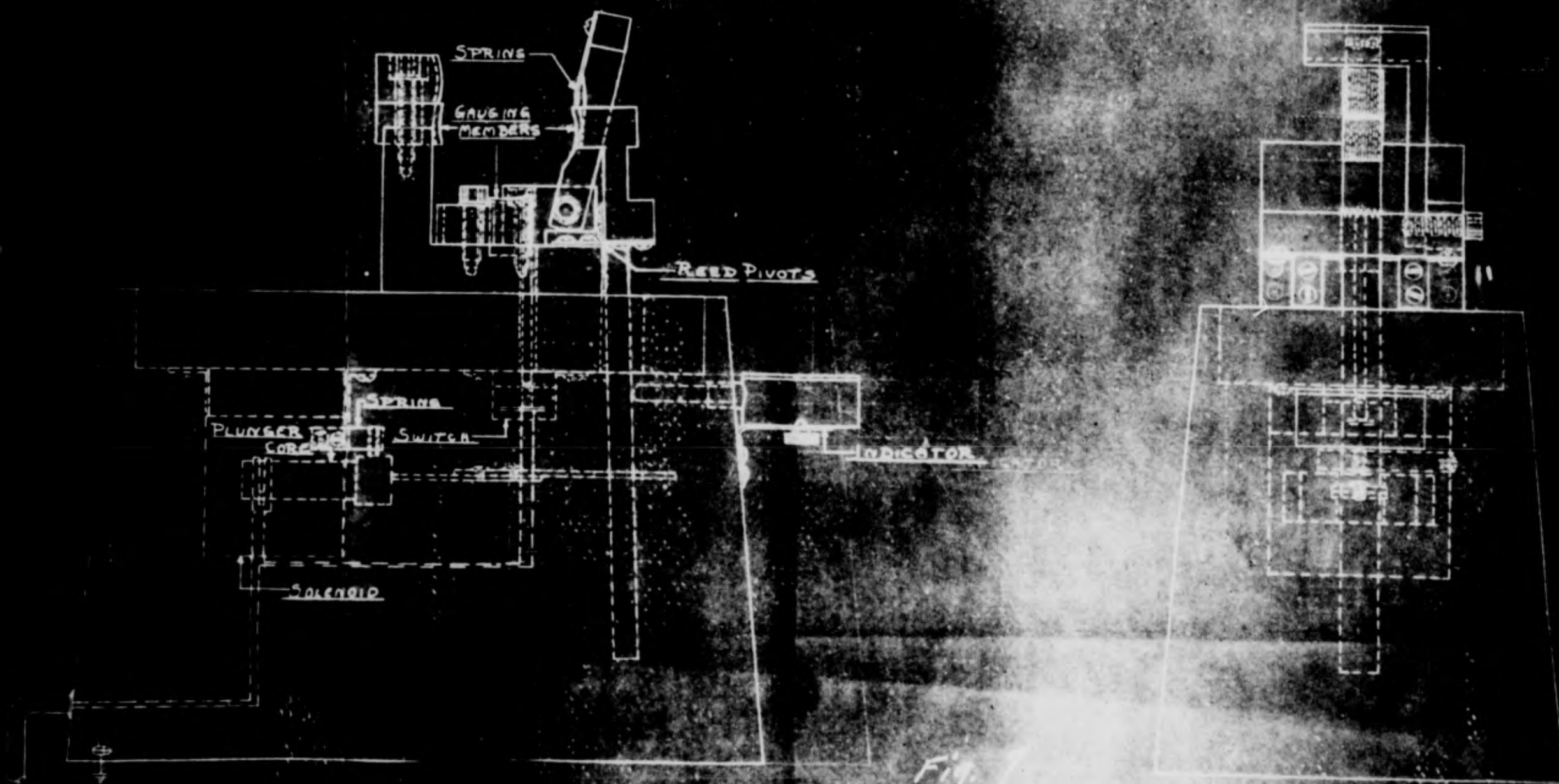


Fig. 1

ANTENNA TUNING GAUGE  
SCALE - FULL

110 A.C.



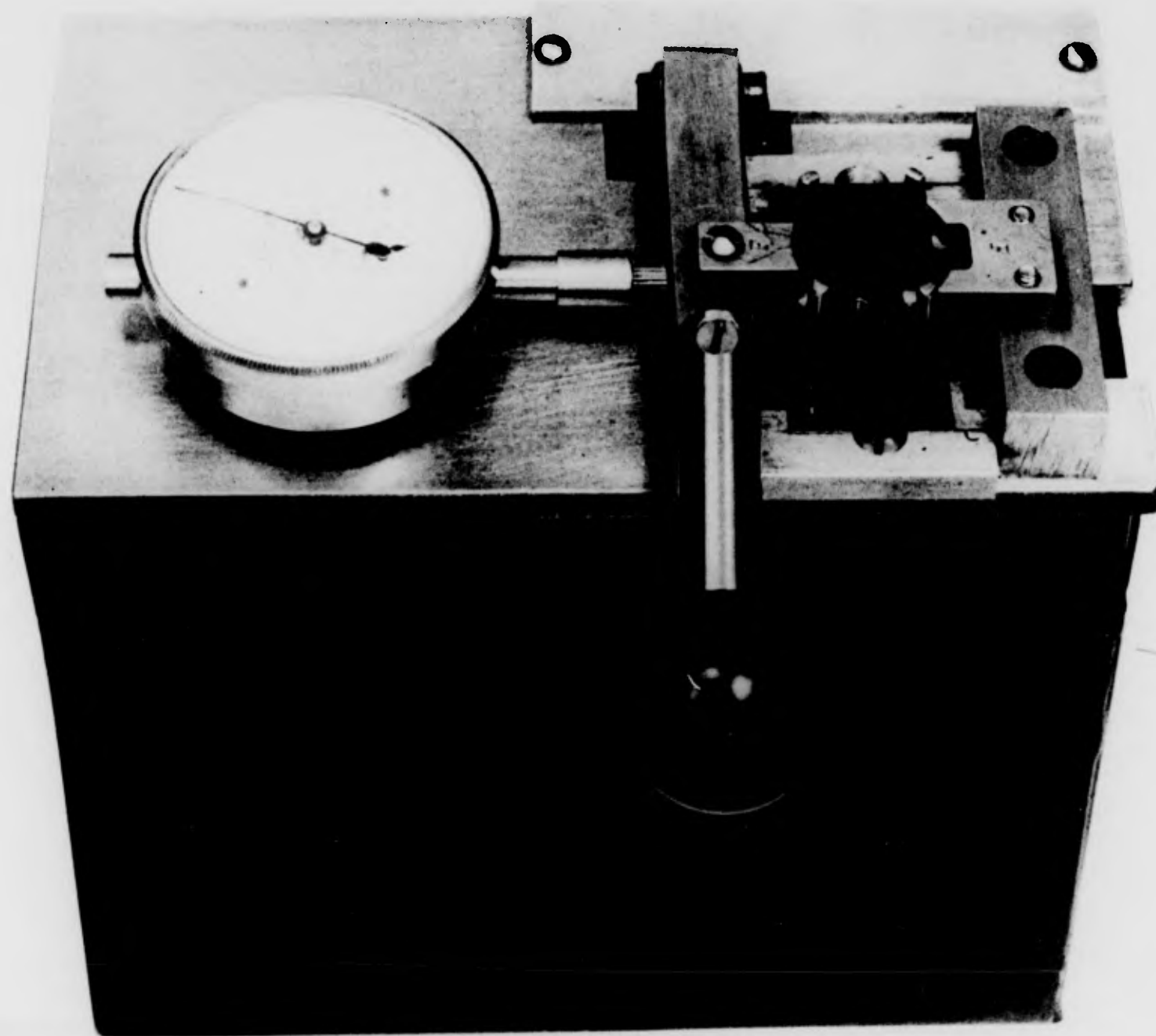
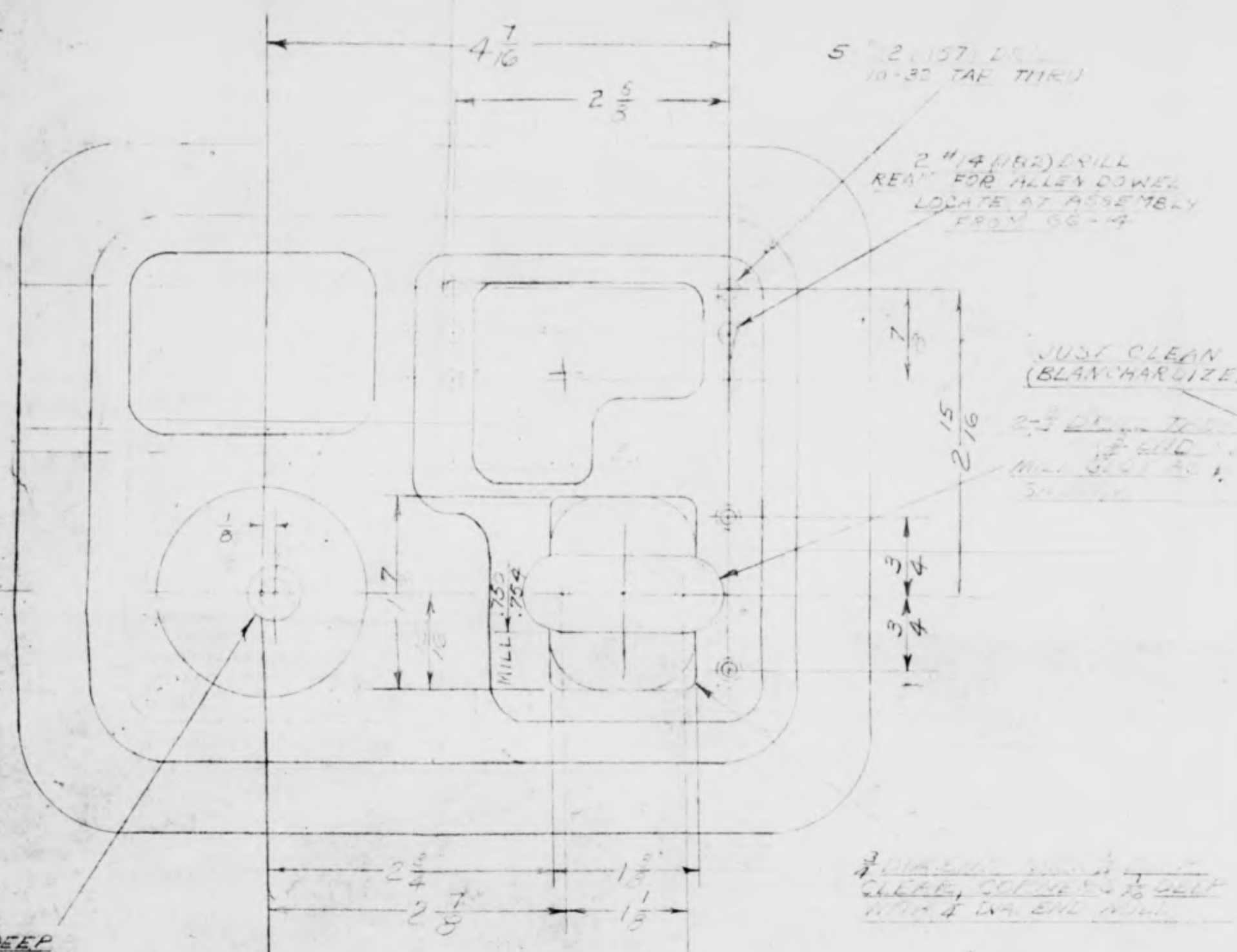
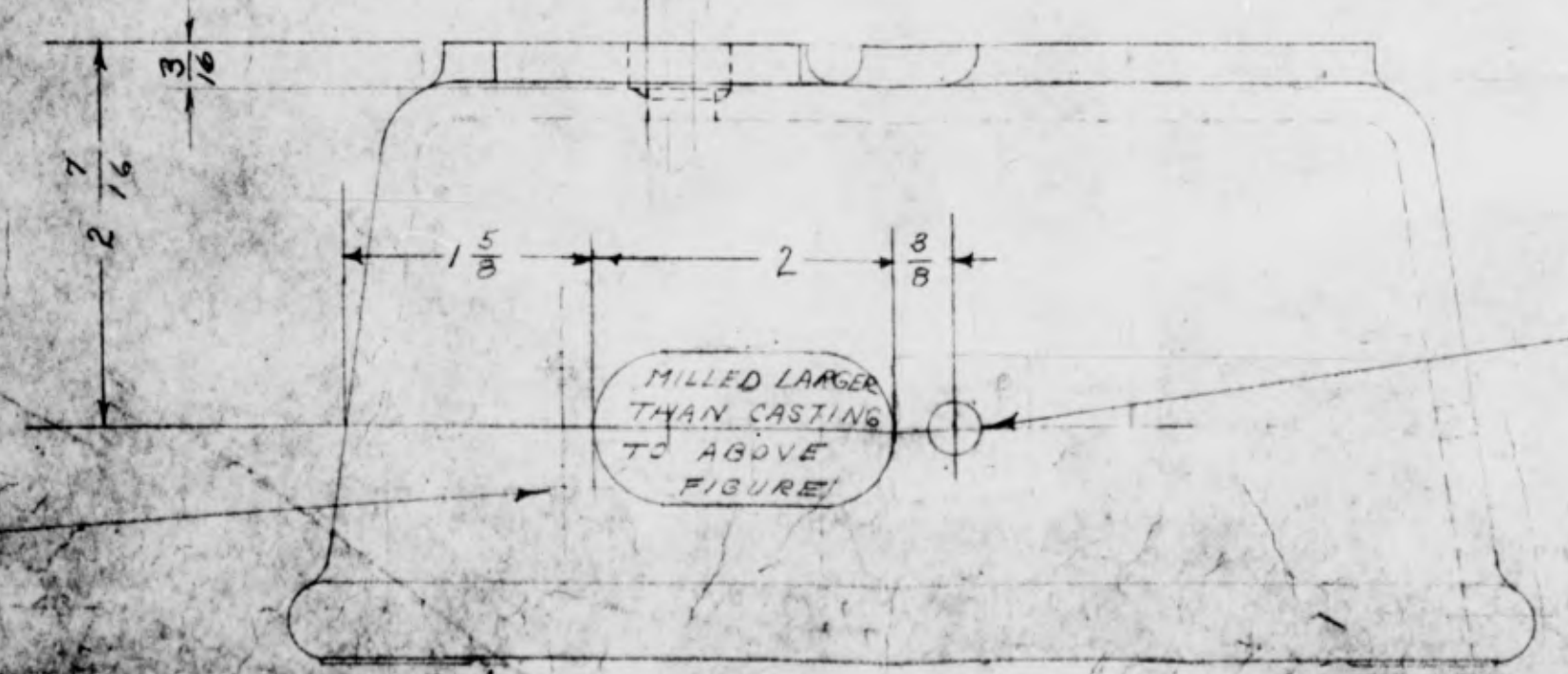


FIG. 8 PILOT MODEL  
MANUALLY OPERATED GAGE  
FOR MALE THREADS



$17\frac{1}{32}$  DRILL  $\frac{9}{32}$  DEEP  
 $32$  DRILL THRU



C.I - X-305

UNLESS OTHERWISE SPECIFIED FRACTIONAL DIMENSIONS UP TO 5" HAVE A TOLERANCE OF $\pm \frac{1}{64}$ OVER 5" HAVE A TOLERANCE OF $\pm \frac{1}{32}$		DATE	CHANGE	DATE
CHANGE RECORD				
DATE 1-11-93	SCALE			
D'WN BY F.H.	CH'KD BY			
BRYANT CHUCKING GRINDER CO. SPRINGFIELD, VERMONT, U. S. A.				



TURN  $1\frac{5}{32}$  DIA.

SMALL CENTER  
BOTH ENDS

2"  $14(.182)$  DRILL - REAM FOR  
 $\frac{1}{16}$  ALLEN PIN AT ASSEMBLY

MILL  $\frac{1}{2}$  1.445  
 $\frac{1}{16}$  1.430

4 -  $\frac{7}{32}$  DRILL THRU  
 $\frac{11}{32}$  C'BORE  $\frac{3}{16}$  DEEP  
90° C'SINK TO  $\frac{13}{32}$  DIA.

1/32" PERMISSIBLE

PLANOGRAPH MILL  
AS SHOWN  
AFTER ASSEMBLY

SQUARE

37MM. APC. T.P. 3H01  
CAP

1-32 NS 2THD B P3155  
ORD. DEPT. USA. INSP.

8 -  $\#35(.110)$  DRILL  $\frac{1}{2}$  DEEP  
 $\#6-32$  TAP  $\frac{3}{8}$  DEEP

C.I. PATT X-306

FEB 12 1945

CHARGE TO B-2-GG-15

UNLESS OTHERWISE SPECIFIED FRACTIONAL DIMENSIONS  
UP TO 5" HAVE A TOLERANCE OF  $\pm \frac{1}{64}$   
OVER 5" HAVE A TOLERANCE OF  $\pm \frac{1}{32}$

A	1-15-43	1-15-43	1-15-43
LET.	CHANGE	DATE	BY

CHANGE RECORD

DATE 1-15-43 SCALE FULL  
OWN BY FEAN CH'KD BY P86

BRYANT CHUCKING GRINDER CO.  
SPRINGFIELD, VERMONT, U. S. A.

6H14 LEVER BRACKET



#22(.157) DRILL &  
10-32 TAP THRU  
LOCATE AT ASSEMBLY  
CENTRAL WITH .750 SLOT

LOCATE REAMED HOLE  
ON VERTICAL CENTER LINE OF BOSS

FEB 13 1943

$\frac{1}{4}$  DRILL THRU -  
 $\frac{5}{8}$  DIA. SPOTFACE

.4998  
.5003 REAM -  $\frac{3}{4}$  DEEP

GRIND TOP  
AT ASSEMBLY  
WITH GG-21  
IN PLACE

8 #35(.110) DRILL  $\frac{1}{2}$  DEEP  
#6-32 TAP  $\frac{3}{8}$  DEEP JIG

REMOVE BURRS  
SAMPLE LOT ARE C.I. THERE -  
AFTER USE "SPEC. IRON FOR STRENGTH"  
C.I.-PATT. X-307

CHARGE TO B-2-GG-15

GG-15

GAUGE LEVER

SEE ASSEM  
GGA-25

UNLESS OTHERWISE SPECIFIED FRACTIONAL DIMENSIONS  
UP TO 5" HAVE A TOLERANCE OF  $\pm \frac{1}{64}$   
OVER 5" HAVE A TOLERANCE OF  $\pm \frac{1}{32}$

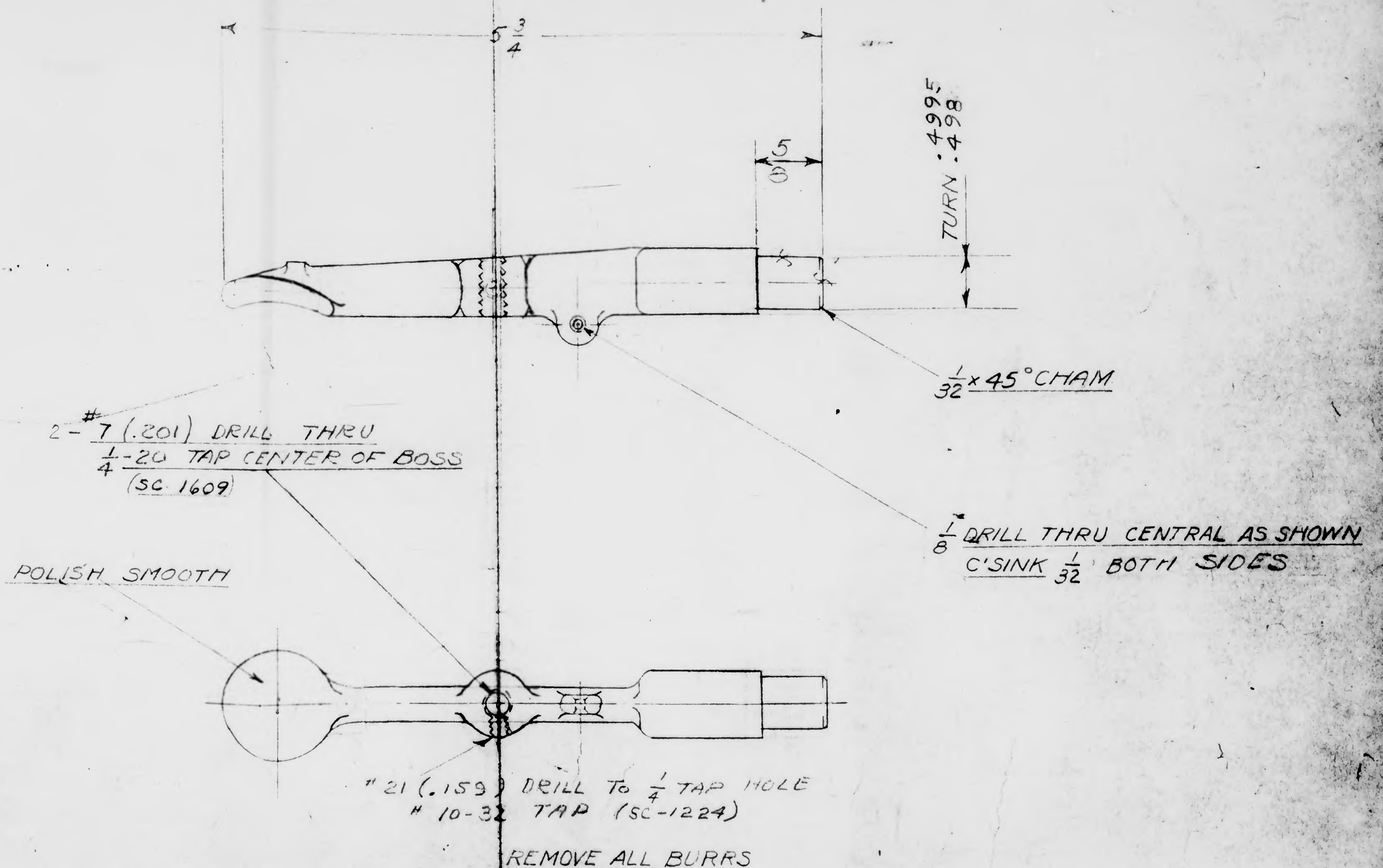
LET. CHANGE DATE

CHANGE RECORD

DATE 1-13-43 SCALE FULL  
D'WN BY JAF CH'D BY

BRYANT CHUCKING GRINDER CO.  
SPRINGFIELD, VERMONT, U. S. A.





C.I. PATT. X-308

FEB 9 1943

CHARGE TO B-2 GG-16

GG-16

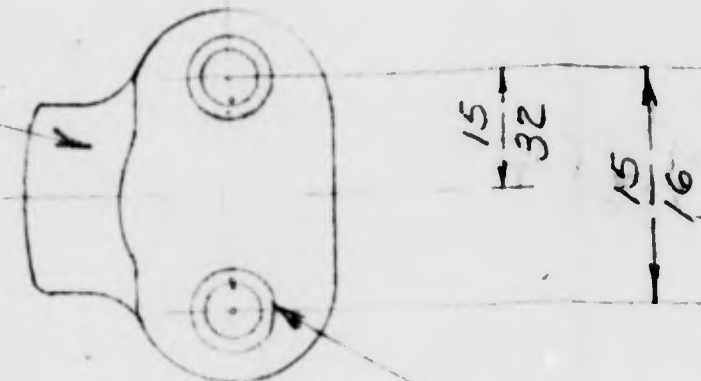
LEVER HANDLE

SEE ASSEM.  
6GA-25

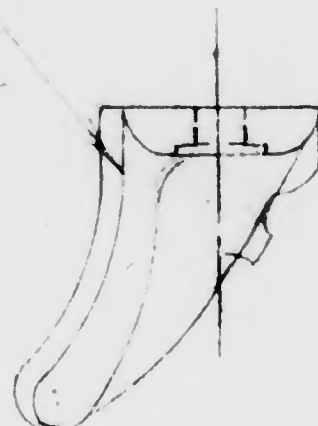
UNLESS OTHERWISE SPECIFIED FRACTIONAL DIMENSIONS UP TO 5" HAVE A TOLERANCE OF $\pm \frac{1}{64}$ OVER 5" HAVE A TOLERANCE OF $\pm \frac{1}{32}$		LET.	CHANGE	DATE	BY
CHANGE RECORD					
DATE 1-12-43	SCALE FULL	BRYANT CHUCKING GRINDER CO. SPRINGFIELD, VERMONT, U. S. A.			
D'WN BY J.A.F.	CH'KD BY E.D.G.				

DISC GRIND THIS  
SURFACE CLEAN

POLISH SMOOTH



2-#8(.199) DRILL THRU  
FOR SC-1227



REMOVE ALL BURRS

C.I. PAT T X-309

FEB 12 1945.

CHARGE TO B-2-GG-17

GG-17

FINGER REST

SEE ASSEM.  
GGA-25

UNLESS OTHERWISE SPECIFIED FRACTIONAL DIMENSIONS  
UP TO 5" HAVE A TOLERANCE OF  $\pm 1/64$   
OVER 5" HAVE A TOLERANCE OF  $\pm 1/32$

LET.

CHANGE

DATE

BY

CHANGE RECORD

DATE 1-12-43

SCALE FULL

D'WN BY JAF

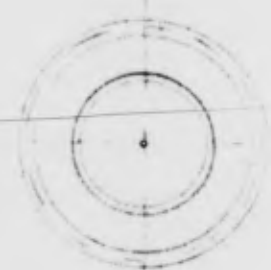
CH'K'D BY

BRYANT CHUCKING GRINDER CO.  
SPRINGFIELD, VERMONT, U. S. A.



$\frac{1}{2}$ " DRILL  
 $\frac{1}{8}$ " DEEP

CENTER  
 BOTH ENDS



GRIND 1-32 U.S. STD.  
TAD. R.H.  
TURN 1.000  
.999  
P.D. .9797  
.9792

Turn 747, 748

GRIND  
PARALLEL

$$\frac{1}{16} \text{ CH}_4 \text{ CH}_3$$


KNURL



MAT.	S. T. S.
TREAT.	
ITEM,	GG-18-2

FEB 13 1945

NAME. J. J. J.  
 TREAT.  
 ITEM. 66-12-1

TIME  
B-2

GG-18

SET UP THREAD PLUG AND WASHER

UNLESS OTHERWISE SPECIFIED FRACTIONAL DIMENSIONS  
UP TO 5" HAVE A TOLERANCE OF  $\pm 1/64$   
OVER 5" HAVE A TOLERANCE OF  $\pm 1/32$

LET.

CHANGE

DATE \_\_\_\_\_

BY

## CHANGE RECORD

DATE 1-9-42

SCALE *F. H. L.*D'WN BY *R/VN*

CH'K'D BY

**BRYANT CHUCKING GRINDER CO.**  
**SPRINGFIELD, VERMONT, U. S. A.**

2-# 25 (1905) DRILL & REAM

.3075  
 .3175

23  
 32

.535  
 .547



.3745  
 .3753 REAM FOR ARBOR

# 25 (1905) DRILL FOLLOW  
 WITH # 23 (134) DRILL

1/2 R REAM

AS SHOWN (GG-24) & PINS (GG-23) TO EDGE (GG-19)  
 THEN GRIND INSIDE OF 1/4 DIA. OF PINS TO 1 1/2 DIA. - GRIND  
 OUTSIDE OF PINS AS SHOWN (SEE GG-23) FOR GRIND &

SQUARE

PARALLEL



REAM SP. 10.00

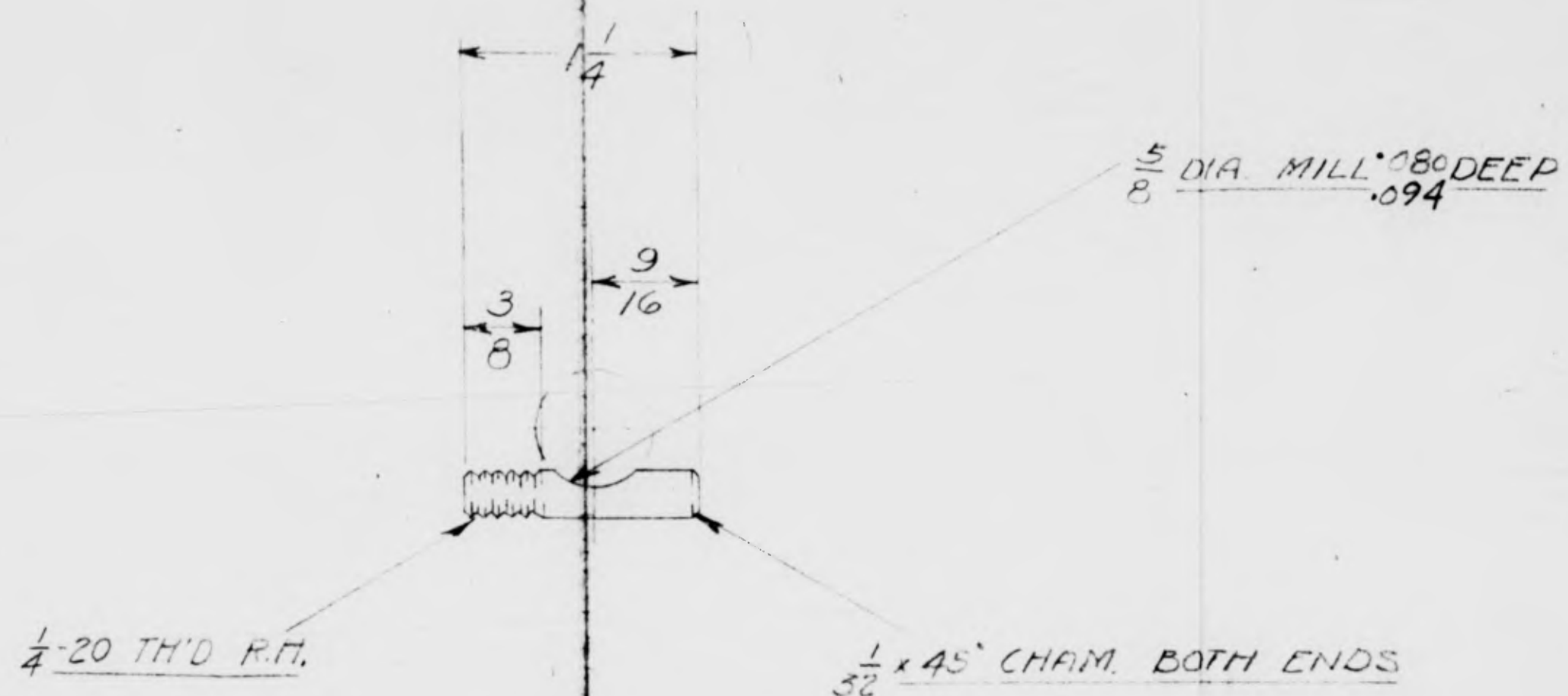
M.S. 1-16

FEB 6 1945

CHARGE TO B2-GG-19

GG-19	WORK NO. 307		
-------	--------------	--	--

UNLESS OTHERWISE SPECIFIED FRACTIONAL DIMENSIONS UP TO 5" HAVE A TOLERANCE OF $\pm \frac{1}{64}$ OVER 5" HAVE A TOLERANCE OF $\pm \frac{1}{32}$		LET.	CHANGE	DATE	BY
CHANGE RECORD					
DATE	SCALE	BRYANT CHUCKING GRINDER CO. SPRINGFIELD, VERMONT, U. S. A.			
D'WN BY	CH'K'D BY				



MAKE FROM  $\frac{1}{4}$  DIA. C.R.S.

BREAK SHARP CORNERS

FEB 13 1945

CHARGE TO B-2 GG-20

GG-20

LOCKING PIN

SEE GGA-25

UNLESS OTHERWISE SPECIFIED FRACTIONAL DIMENSIONS  
UP TO 5" HAVE A TOLERANCE OF  $\pm \frac{1}{64}$   
OVER 5" HAVE A TOLERANCE OF  $\pm \frac{1}{32}$

LET.

CHANGE

DATE

BY

CHANGE RECORD

DATE 1-14-43

SCALE FULL

D'WN BY JAF

CH'K'D BY E. J. 10

BRYANT CHUCKING GRINDER CO.  
SPRINGFIELD, VERMONT, U. S. A.



NOTE  
MATCHED SEGMENTS MUST  
BE LAID OUT EXACTLY OPPOSITE  
BEFORE SAWING

Fig. 1

SAW BEFORE HANDLING AS SHOWN FIG. 1

NUMBER SEGMENTS  
IN PAIRS AS SHOWN

LEGS OF SEGMENTS  
APPROX  $\frac{1}{8}$  WIDE AT BEARING  
POINT OF THREAD

8 (.199) DRILL - 6 HOLES

HEAT TREATMENT

PREHEAT TO 1250°  
QUENCH IN HOT OIL FROM 1480°  
DRAW AT 325° FOR 1½ HRS.

LOAD FIXTURE  
AS SHOWN

KETOS — HARDEN

BREAK SHARP CORNERS

GRIND PARALLEL  
& SQUARE WITH  
THREAD

30° BEVEL  
BOTH SIDES .065

10 TIMES SCALE  
THREAD FORM

.940  
BORE .945

GRIND .9617  
GRIND .9613 DIA.  
GRIND 1-32 TH'D RH

CHARGE TO B-2-GG-22

GG-22

GAGE JAWS (FOR CLASS 2 THREAD)

UNLESS OTHERWISE SPECIFIED FRACTIONAL DIMENSIONS  
UP TO 5" HAVE A TOLERANCE OF  $\pm \frac{1}{64}$   
OVER 5" HAVE A TOLERANCE OF  $\pm \frac{1}{32}$

LET.

CHANGE

DATE

BY

CHANGE RECORD

DATE 1-19-43

SCALE FULL

D'WN BY JAF

CH'K'D BY Fern

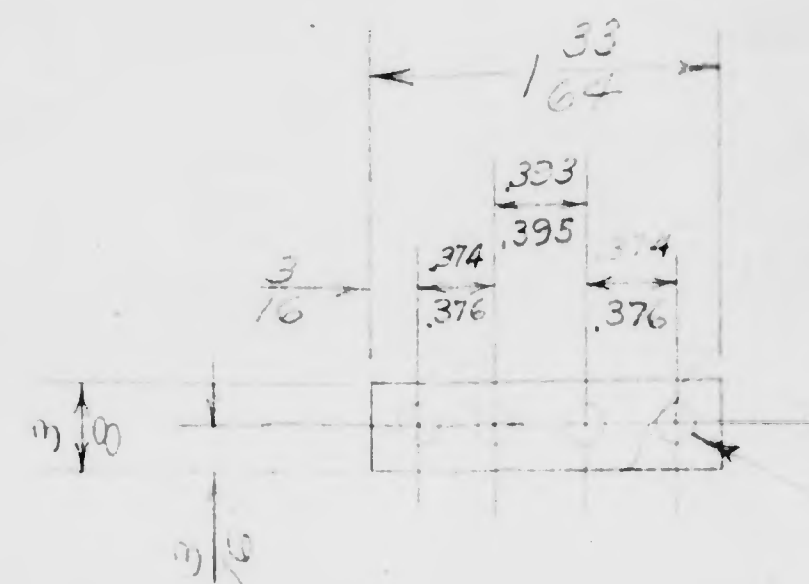
BRYANT CHUCKING GRINDER CO.  
SPRINGFIELD, VERMONT, U. S. A.





UNLESS OTHERWISE SPECIFIED FRACTIONAL DIMENSIONS UP TO 5" HAVE A TOLERANCE OF $\pm \frac{1}{64}$ OVER 5" HAVE A TOLERANCE OF $\pm \frac{1}{32}$		(A) WAS .018		2-19-42	
		LET.	CHANGE	DATE	BY
		CHANGE RECORD			
DATE 1-19-42	SCALE FULL	BRYANT CHUCKING GRINDER CO. SPRINGFIELD, VERMONT, U. S. A.			
DRAWN BY	CHECKED				





4 HOLES .140 DIA. (#28 DRILL)  
.142

BREAK SHARP EDGES

4 REQ. MAT  $\frac{3}{8}$  x .018 STEEL SPRING STOCK

HEAT TREATMENT

QUENCH IN OIL FROM 1450°

TEMPER AT 800°

ROCKWELL C 42-47

FEB 12 1943

CHARGE TO B-2-GG-25

GG-25

REEDS, FOR LEVER

UNLESS OTHERWISE SPECIFIED FRACTIONAL DIMENSIONS  
UP TO 5" HAVE A TOLERANCE OF  $\pm \frac{1}{64}$   
OVER 5" HAVE A TOLERANCE OF  $\pm \frac{1}{32}$

LET.

CHANGE

DATE

BY

CHANGE RECORD

DATE 1-19-43

SCALE FULL

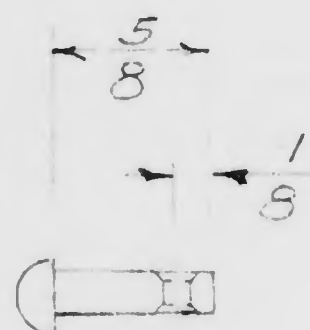
D'WN BY

CHK'D BY

BRYANT CHUCKING GRINDER CO.  
SPRINGFIELD, VERMONT, U. S. A.

Feb 14 1945

JAMES H. KING & SONS CO.



5 DRILL THRU  
67 C'SINK AS SHOWN



MAKE FROM R-893 CHARGE TO B-2-GG-27

GG-27

FASTENER-SPRING TO BASE

UNLESS OTHERWISE SPECIFIED FRACTIONAL DIMENSIONS  
UP TO 5" HAVE A TOLERANCE OF  $\pm \frac{1}{64}$   
OVER 5" HAVE A TOLERANCE OF  $\pm \frac{1}{32}$

LET.	CHANGE	DATE	BY
------	--------	------	----

CHANGE RECORD

DATE 1-27-43

SCALE FULL

D'WN BY JAF

CH'K'D BY

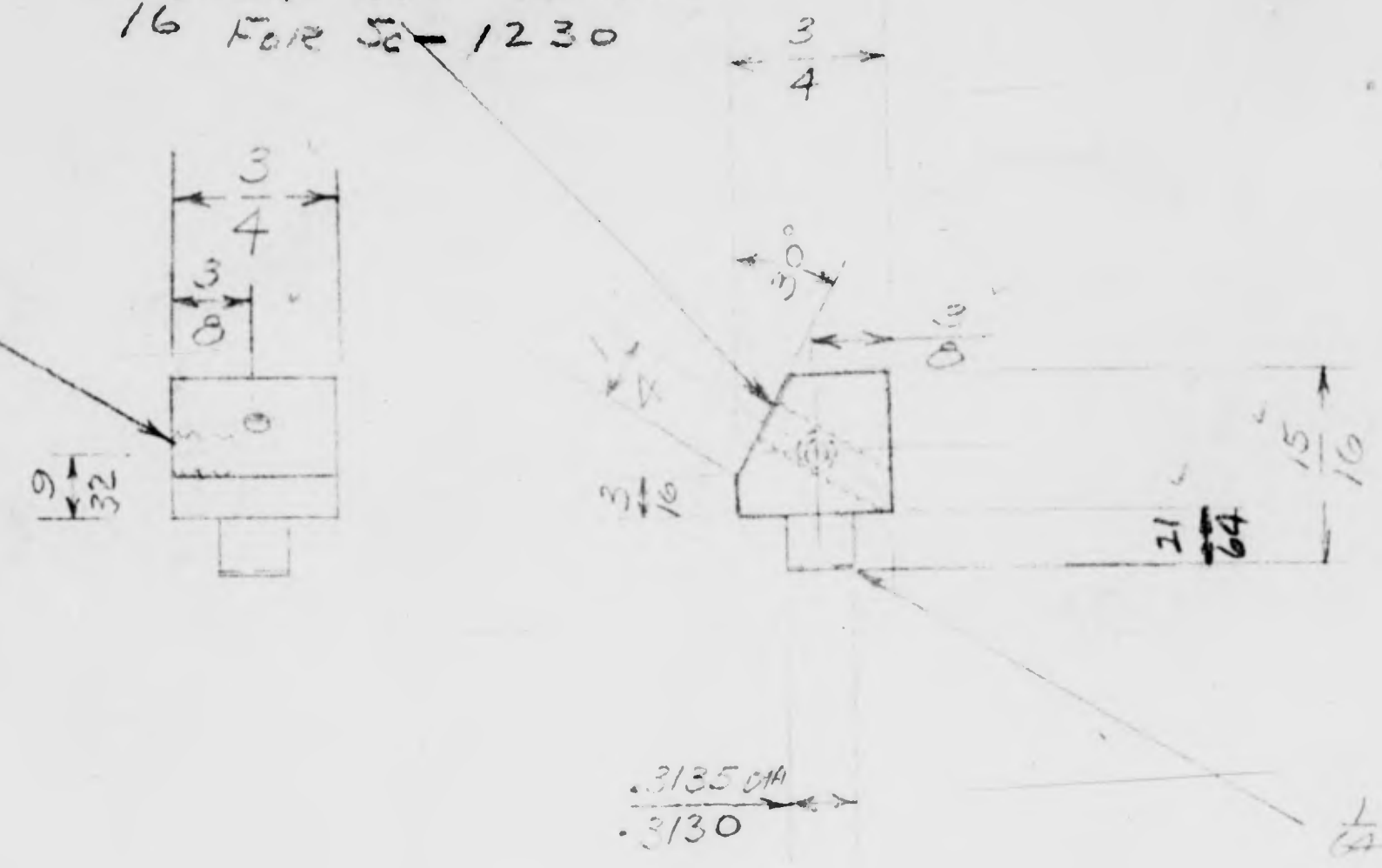
BRYANT CHUCKING GRINDER CO.  
SPRINGFIELD, VERMONT, U. S. A.





#26 (.147) DRILL THRU  
 $\frac{3}{16}$  - 24 TAP THRU  
 FOR SC-1230

#26 - (.147) DRILL  
 $\frac{3}{16}$  - 24 TAP  
 FOR SC-1225



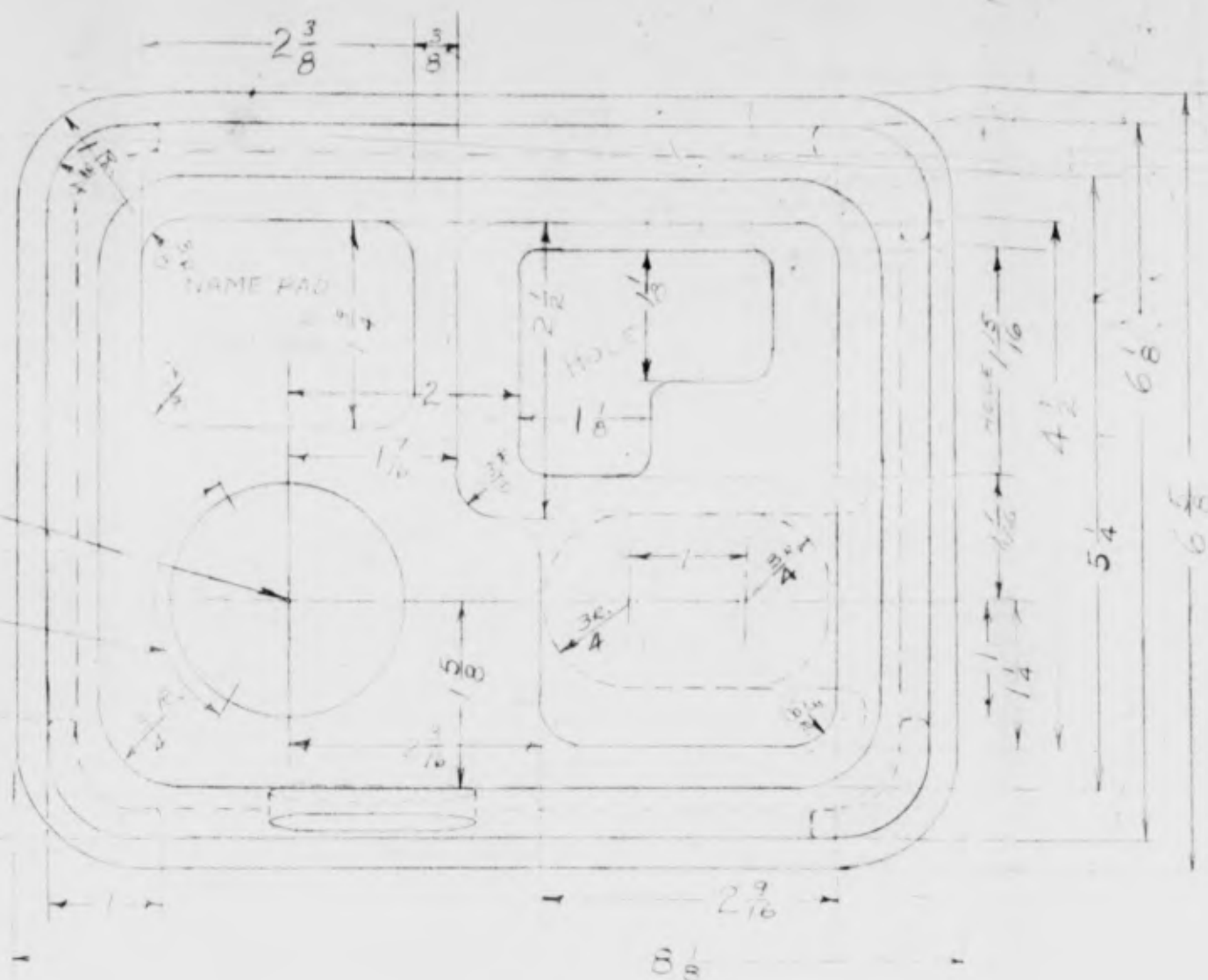
FEB 13 1945

UNLESS OTHERWISE SPECIFIED FRACTIONAL DIMENSIONS UP TO 5" HAVE A TOLERANCE OF $\pm \frac{1}{64}$ OVER 5" " " " OF $\pm \frac{1}{32}$		BRYANT CHUCKING GRINDER CO. SPRINGFIELD, VT. U.S.A.
2-10-42	FULL SCALE	
DWN. JAF	CHKD. Edo	

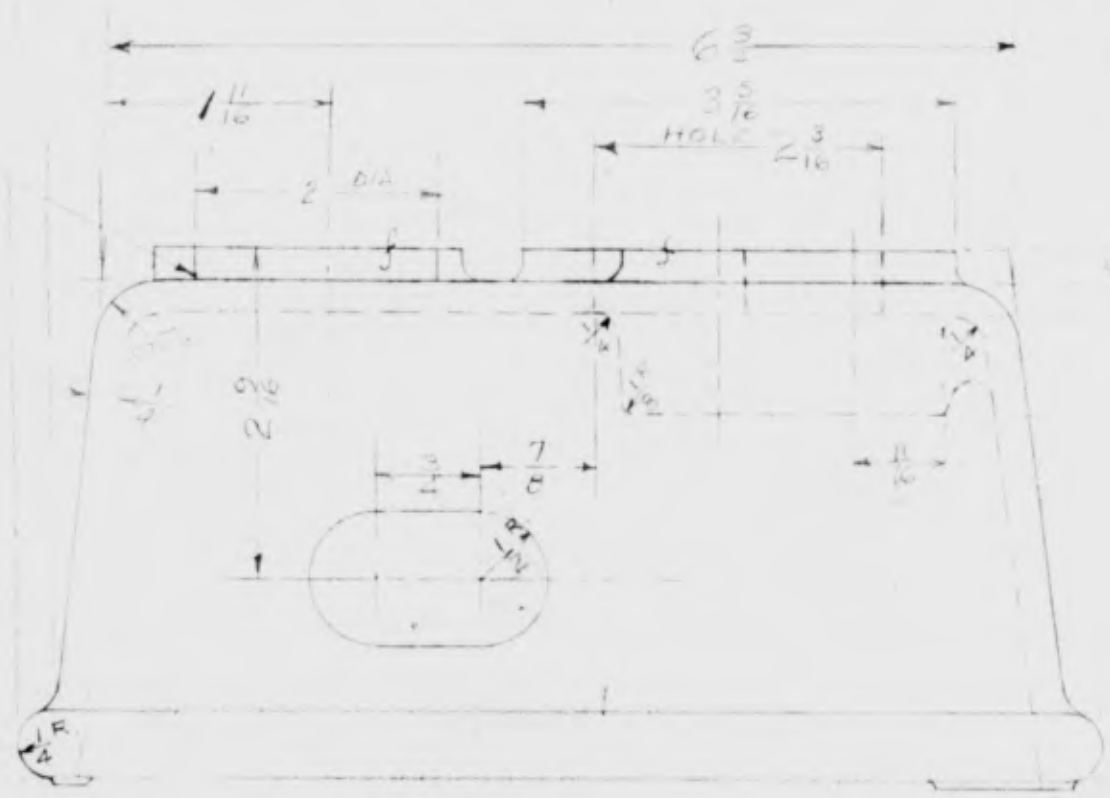
GG 28

CHARGE TO B-2 GG 773

X-305 X-306 X-307

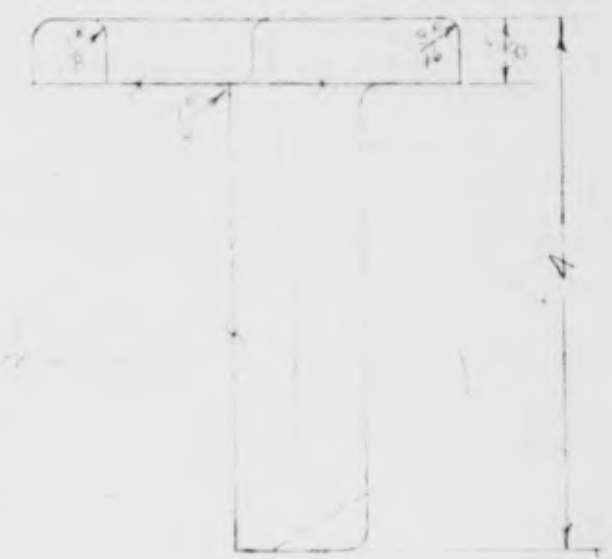
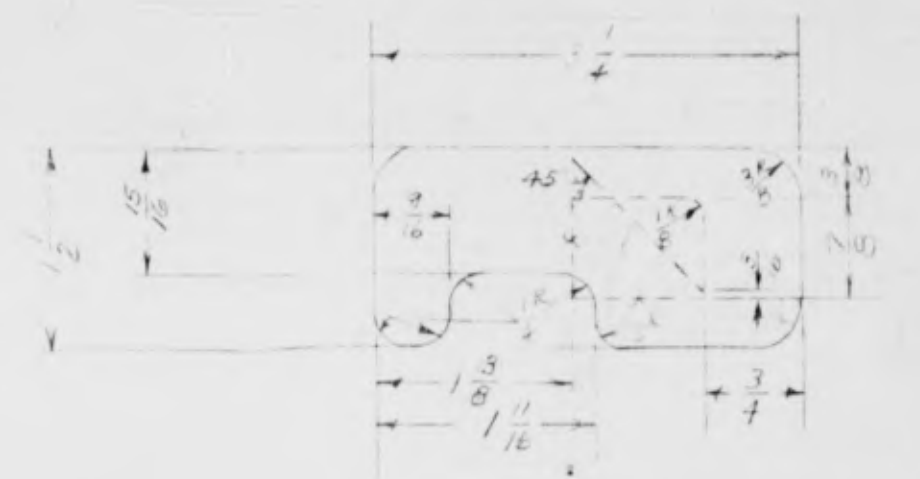


STARTING POINT  
FOR ALL DIMENSIONS



NO FILL & T

DATE X-305  
MATERIAL CAST IRON  
DUST GG-13  
MACHINE  
NUMBER B-2



X-327  
I SPEC FOR STRENGTHEN  
32-15

PATT. DWG.

X-305 X-306 X-307

